THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 44. Thursday, June 4, 1931. No. 772.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

Contents.

	PAGE
Forthcoming Events	381
The Pocket Battleship	381
A Chance of a Lifetime	381
Correspondence	382
The American Exchange Paper	382
Random Shots	382
The Foundry of the Midland Electric Manufacturing Company, Limited	383
Enterprise in Motherwell	384
A Novel Drying Stove	385
A New Design of Sand-Blast Room	386
Cast Alloys for High-Temperature Service	387
Melting Grey and Malleable Iron in the Indirect-Arc Furance	391
The Production of an Aluminium-Alloy Casting	392
A Large Single-Faced Sluice	392
Notes from I.B.F. Branches	392
Trade Talk	393
Reports and Dividends	393
Personal	393
Obituary	393
Iron and Steel Markets	394
Birmingham Convention Fund	394

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT: 1930-31:
P. P. Wilson, J.P.,
"Parkhurst," Middlesbrough.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.

Birmingham: F. K. Neath, 24, St. Paul's Square, Birmingham.

Sheffield: T. R. Walker, 33, Ladysmith Avenue, Nether Edge, Sheffield.

Scottish: J. Bell, 60, St. Enoch Square, Glasgow.

Lancashire: J. E. Cooke, 1, Derbyshire Crescent, Stretford, Manchester.

London: Sydney Evans, 22-23, Laurence Pountney Lane, Cannon Street, London, E.C.4.

Newcastle-upon-Tyne: J. W. Eckford, 4, Mosely Street, Newcastle-upon-Tyne.

East Midlands: H. Bunting, 82, Otter Street, Derby.

West Riding of Yorkshire Branch: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.

Wales and Monmouth Branch: J. J. McClelland, 12, Clifton Place, Stow Hill, Newport, Mon.

Middlesbrough: F. A. Harper, "The Briars," Bishopton Road, Stockton-on-Tees.

Foundry Trades Equipment and Supplies Association.

President: D. H. Wood,
Titan Works, Charles Henry Street, Birmingham.

Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 2, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION.

The Registered Office and Laboratories of the B.C.I.R.A. are at:—
24, ST. PAUL'S SQUARE, BIRMINGHAM.
Telephone: Central 1895. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 232).*

Forthcoming Events.

Institute of British Foundrymen.

JUNE 9-12.
Annual Conference at Birmingham.

JUNE 13.
Lancashire Branch:—Visit to works of Linotype & Machinery, Limited, Altrincham.

The Pocket Battleship.

The newspapers have recently given a good deal of space to the launch of the German vessel known as the "pocket battleship" on account of the fact that she left the slips prematurely before the official launching ceremony. Few, if any, pointed out the real significance of this achievement.

The Treaty of Versailles restricts Germany to war vessels below 10,000 tons and guns of or below 11 in., but she is not restricted as to what she may spend, and the result is a vessel costing double what would have normally been spent on a standard cruiser of the same displacement. This vessel is well protected and has a speed of 26 knots. What does all this mean?

It means that an intensive development has taken place on the metallurgical end, and especially on design. It is said that this armoured cruiser is driven by featherweight Diesel engines of secret design, and thus combines the fighting capacity of a battleship with the speed of a cruiser. Three sister-ships are to be built before 1936.

There is little doubt that this vessel sets a new standard in warship design as great as that of the original Dreadnought, and its production must cause all the naval powers furiously to think. By brains, skill, and careful design, what was intended as a restriction has been turned into a positive advantage. She could outrange and outstrip with ease any other vessel of similar displacement.

The engines are double-acting, two-cycle engines of the M.A.N. type, developing 50,000 h.p., with quadruple screws. It is said that electric welding and special alloys have been used throughout the ship irrespective of expense, with a weight saving of 550 tons. It is said that the engines develop 1 h.p. for 17.5 lbs. of weight.

The Washington treaty encouraged the production of fast cruisers with little armour protection and 8-in. guns. The other naval powers, Britain included, can now do two things. They can build bigger ships so as to have the means of outranging this new type, like the French 23,000-ton vessel with 12-in. guns, or they can build on the same lines and produce a vessel no larger but better and speedier. The former method, taking advantage of the Versailles treaty, is wrong; an admission of technical inferiority. The courageous way is to use all our brains and skill and metallurgical knowledge in making a vessel as swift and strong and cheaper than the *Deutschland*. It can be done, but the heavy industry, and especially the founding industry, would have to co-operate with the Admiralty for the production of materials of a higher grade than has hitherto been the case.

A Chance of a Lifetime.

Only twenty-five British firms making builders' castings now remain detached from the British Ironfounders' Association, yet that is sufficient to make this section of the foundry industry the butt for every unscrupulous builders' merchant throughout the land. It renders the importation of foreign-made material the easiest possible commercial operation. It weakens the bargaining capacity of the industry as a whole, at a time when unity is of more importance than at any other period in history. Here is a typical news item, the interpretation of which we leave to the *savoir faire* of these twenty-five foundries: "The Technical and Economic Advisory Council for the Building Industry has now drawn up a draft constitution which is to be submitted to the affiliated organisations for consideration. Since the formal inauguration of this movement, a considerable number of other bodies have joined. The main object of the Council, as set out in the draft constitution, is to act as a medium of communication between the professional and trade organisations represented and Government and local authorities entrusted with the statutory control of buildings." If our interpretation is correct, the successful culmination of this movement will mean a vast increase of orders placed with its affiliated members, at an economic price. As is indicated in the quoted paragraph, the foundry industry is only one of many trades represented, and the stronger and more unanimous its representation the greater the chance of success of this extremely ambitious scheme. The question which every manufacturer of builders' castings must pose to himself and answer very quickly is: "Am I to allow my industrial activities to be subjected to the full blast of home and foreign cut-throat competition, or should I co-operate with my fellow-sufferers and immediately eliminate the former, whilst instituting conditions extremely favourable for alleviating, if not totally abolishing, the latter?"

We are personally satisfied that joining the British Ironfounders' Association, viewed from the purely selfish point of view or its reaction on the related industries, the operatives or the general public, is a step which can be advantageously, conscientiously and unhesitatingly taken by manufacturers of light castings.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

London Iron and Steel Exchange.

To the Editor of The Foundry Trade Journal.

Sir,—Your leader, entitled "An Industrial Conscience for the South," in your issue of May 21, touched upon a subject which has engaged the earnest consideration of the Committee of this Exchange, which desires nothing better than, in your own words, "to broaden its sphere of activity by serving the local foundry industry."

The Committee is very much alive to the growth of the foundry industry in London and the South, and it has been in communication with various organisations associated with the foundry industry with a view to forming a special foundry section of the Exchange, which would interest itself in questions affecting the commercial side of the industry. At the same time, it is thought that the weekly meetings of the Exchange would provide an opportunity for founders, their customers and their suppliers to meet and discuss business.

You, Sir, have pointed out further arguments in favour of the development of this scheme, which is receiving the support of a number of prominent firms. I should be pleased if any of your readers who are interested would communicate with me at the address below. I may add that the membership of the London Iron and Steel Exchange already includes a number of firms closely connected with the foundry industry.—Yours, etc.,

J. C. Sumption,
Secretary.

The London Iron and Steel Exchange,
28, Essex Street, Strand,
London, W.C.2.

May 27, 1931.

The Taylor Bell Foundry.

To the Editor of The Foundry Trade Journal.

Sir,—We were very pleased to notice the prominent mention of our name in your issue dated May 21, 1931, on page 352, under the heading, "The Brothers Pennington—Bell-founders," in connection with the restoration of the bells at St. Budeaux Parish Church. It is stated, however, that our company was founded a century ago by a native of Buckland Brewer, North Devon, but, as you will see from the enclosed booklet, "The Taylor Bell Foundry," the history of our firm goes back to 1366, and the first Taylor in the business, Robert Taylor, was born in 1760. Actually, John Taylor, the son of the aforementioned Robert Taylor, migrated from Oxford to Buckland Brewer in 1825, staying there eight years.—Yours, etc.,

John Taylor & Company.

Bell Foundry,
Loughborough.
May 27, 1931.

[We sincerely thank Messrs. John Taylor & Company for the correction and for sending us much very interesting literature.—Editor.]

It is reported from Johannesburg that the Union Steel Corporation of South Africa—in which the South African Iron & Steel Corporation, the Government-subsidised concern, recently acquired a controlling interest—has now acquired control of the South African Bolt & Nut Factory, which has been financially reconstructed. The Newcastle blast furnace is to be restarted in August. Incidental thereto, the Prestwick iron-ore mine is resuming production after a two years' stoppage. At Prestwick, proved ore reserves would satisfy the Corporation's requirements for a further ten years.

The American Exchange Paper.

A BRIEF BIOGRAPHY OF ITS AUTHOR.

Mr. L. W. Spring, author of the American Exchange Paper to be presented at the Birmingham Convention next Wednesday, was born in Coldwater, Mich., where he received an early education in the public schools. On graduation from the University of Michigan, Ann Arbor, Mich., with the degree of A.B. in chemistry, Mr. Spring took a position as chemist with the Illinois Steel Company, South Chicago, Ill., remaining there two years. From 1901-02 he served in a similar capacity with the Wolverine Portland Cement Company, and then returned to the Illinois Steel Company for metallurgical and superintendency work in the plate mill. Mr.

Mr. L. W. Spring.

Spring became associated with the Crane Company, Chicago, in 1904, with which company he has remained ever since. He served as chemist for two years, was in charge of the laboratories from 1906-14, and has been chief chemist and metallurgist since 1914. He has prepared various articles on the chemical and physical testing of metals and on metallurgical-engineering subjects, and is author of "Non-Technical Chats on Iron and Steel." He is also a member of the American Foundrymen's Association, A.S.S.T., A.S.T.M., A.I.M.E., American Chemical Society, the Institute of Metals, the American Society for the Advancement of Science, and the Chemists' Club of Chicago.

British Engineering Standards Association.

Proposed Change of Title.

At an extraordinary general meeting of the British Engineering Standards Association, held on May 19, proposals to reorganise on a wider basis the activities of the Association were considered. Under the scheme there will be a General Council and four divisions, embracing: (1) Engineering, (2) Chemistry, (3) Building and (4) Textiles.

There will also be Divisional Councils to superintend each of the divisions. A petition is being presented to the Privy Council for a supplemental Charter and new Bye-laws to enable this reorganisation to be carried through. Subsequently the title will be changed to "The British Standards Institution."

Random Shots.

During the past week the front pages of my morning newspaper have very much resembled a series of balance sheets. To find any reference to the sport of kings, and more especially to the Derby, I had to look in all sorts of queer corners. One of these days we shall be hearing such remarks as "What an exciting sweepstake the Derby was!"

* * *

Rumour whispers that a certain member of the Left Wing was to have addressed a public meeting on the subject of "Sweepstakes—A Menace to the Ideal of Socialism." His non-appearance was attributed to his success in drawing a horse in the Irish sweepstake. "Share and share alike" is a very attractive principle—when you have less than other people to share.

* * *

An elderly gentleman was arrested on the Downs yesterday for attempting to sell tickets of admittance to the original Epsom salt mines.

* * *

The New York night-club queen, Texas Guinan (whether Miss or Mrs. remains to me a mystery), has all the assurance of one who has been weaned on a certain little grey book. Every civilised country, she declared at Plymouth, wants to see her twenty-two "Whoopee" beauty chorus girls. England would want her very shortly. But whether the latter statement is a prediction or the cry of a guilty conscience I am puzzled to say.

* * *

Apparently Miss (or Mrs.) Guinan does not suffer from "Buyers' Disease," the infectious mental ailment which causes complete loss of confidence.

* * *

Someone has given me a cutting of the "wise-cracks" that a London pavement-artist chalks upon his "canvas." Here they are.

"Few men can make a joke and drive it home. Henry Ford did."

"A man's fall is often due to a slip of a girl."

"The more we see of modern girls—the more we see."

"The reason that very few women take up the law is that they prefer to lay it down."

"A flirt is a girl who has made up her mind not to make up her mind."

* * *

Are our short-story writers becoming metallurgical-minded, or are our Bright Young Metallurgists, easy victims to the glowing advertisements anent the "Hobby that Pays," being enticed to enter the less serious fields of authorship? This question came to my mind when I encountered in a magazine the following passage. "Her hair, he observed, repeated the exact hue of the burnished brass nuts which attach the inlet manifold of a 'Greyhound' to the cylinder block, and he felt deeply impressed by her beautifully machined arms, which made all the other women's arms look like rough castings." This approaches nearer to realism than the nonsense about the man of iron who will steel himself to further efforts.

Marksman.

The Foundry of the Midland Electric Manufacturing Company, Limited.

AN OUTSTANDING EXAMPLE OF MECHANISATION.

The foundry department of the Midland Electrical Manufacturing Company, Limited, of Barford Street, Birmingham, to our mind represents an extremely intelligent example of the mechanised manufacture of grey-iron castings. Moreover, the scheme has been developed without a capital expenditure of a serious nature.

The firm, which was established in 1908 by Mr. W. L. Barber, the present managing director, carries on a large and important business devoted to the quantity-production of electrical switch and fuse gear. Not only do they manufacture their own castings, but also the porcelain parts as well. Further, they do their business remarkably efficiently. Each operation is scientifically timed by the process department, using stop watches in conjunction with previous experience, and a rate-fixed time established. If the time taken exceeds the time allowed by one-fifth, no bonus is paid; as the time taken is reduced, a bonus in the form of an increasing percentage on flat rate is paid. Cognisance is taken of the inability of a man to produce because of a lack of supply of raw material or a breakdown of a machine. When this occurs he immediately clocks on to "idle time." Here the foremen and maintenance staff have their efficiency queried, and the cost department, who have before them merely numbers and cyphers, automatically place such occurrences on the agenda for the monthly staff meetings, and an explanation has to be given.

These agendas make interesting reading, as, not only do they show individual, sectional, departmental and general factory efficiency, but all changes in the prices paid for materials and changes in supplies are noted, and explanations required and given. Adequate safeguards exist for protecting the individual against an abuse, such as the unwarranted registering of "idle time," which would show badly against the foreman concerned.

The whole organisation is definitely modern, and full use is made of the results of research into human fatigue and the influence of rest pauses and the like. For the first time in any foundry we actually encountered a wire waste-paper basket half-filled with cigarette boxes, orange peel and the like!

Situation.

The foundry department is located in Charles Henry Street, a few hundred yards away from the main factory. It is not particularly well situated from the point of view of receiving raw materials, as no sidings are available and everything has to be brought in by lorry, nor is there, in the immediate vicinity of the cupolas, a generous amount of space for stocking. However, by a real insistence on tidiness, reasonable stocks can be carried.

Melting Plant.

Melting is carried out in two cupolas, of the Constructional Engineering Company's make, of 25 to 30 cwt. an hour capacity. An electrically-operated hoist takes the weighed charges to the platform. The blowing plant consists of a No. 24 Alldays Duplex fan, and is in duplicate to minimise any danger of loss of production from stoppage. The cupolas, which are worked continuously throughout the day, operate on alternate days, and the daily make averages 12 tons. The metal is caught in hand shanks by the pouring gang, and even in the case of the loose-pattern moulders it is *not* handled by the moulders.

For the firm's production no core shop is necessary, and only very few moulds are made which do not leave their own core. There are just a few patterns of switch boxes left which require to have the holes in their feet cored out.

The Continuous Foundry.

As will be seen from Fig. 1, the continuous section of the foundry is provided with six D.F.4 Bonvillain & Ronceray hydraulic-squeezing slip-flask machines. The moulds are made in less than a minute—actually 50 secs. was returned by stop-watch timing continuously during the time of our visit. One of the two operators attached to each machine, we noticed, invariably placed a shovelful of facing sand on the riddle immediately after filling the frame with backing sand, thus eliminating half the picking up and putting down of the shovel. The mould is placed on a plate and pushed down one of two gravity roller conveyors running away

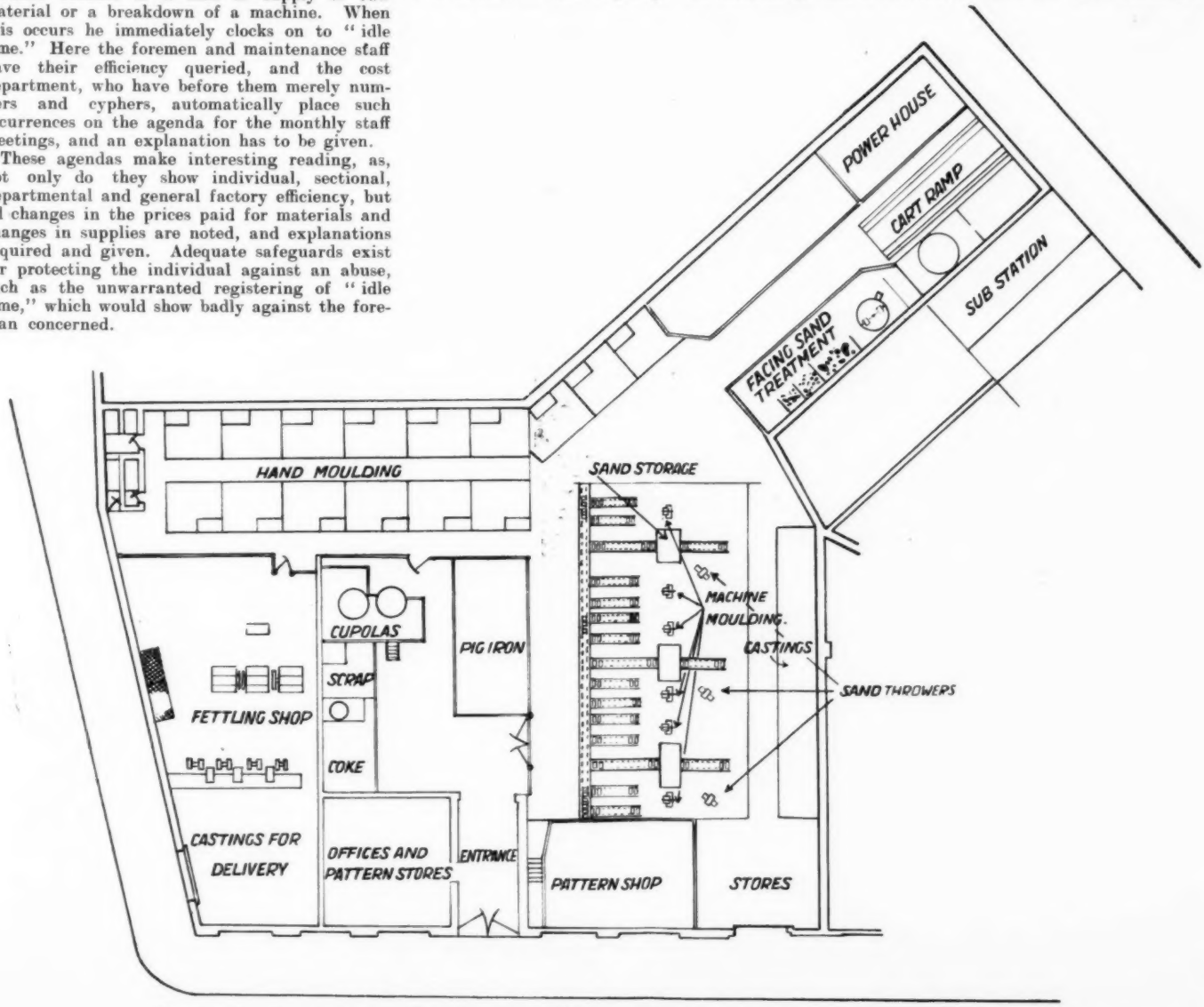


FIG. 1.—THE LAY-OUT OF THE FOUNDRY AT THE MIDLAND ELECTRIC MANUFACTURING COMPANY, BIRMINGHAM.

from the front of the machine. This roller path meets a second one running at right-angles to it, called in the shop the Pourway. Here the moulds are weighted and teemed by the pouring gang. After casting, the weights are removed, and the mould is sent along a roller conveyor at right-angles to the Pourway and parallel to the fresh-mould conveyors. It passes through a tunnel made in the sand bin situated between each pair of machines. The conveyor terminates just at the back of the moulding machines, and here the moulds are broken from the castings. The sand is put through a Coleman-Prosama sand mixer and thrower, which shoots its product into the sand bin. The moulder then draws his backing sand from the bottom, the facing sand being brought by barrow, having been prepared in a Constructional Engineering Company sand mill and placed conveniently near the backing sand. Thus this very efficient continuous plant consists of a roller conveyor for fresh mould, a common "pourway" conveyor, and three cast-up mould conveyors, working in conjunction with a sand-thrower and a storage hopper. What could be more simple? Yet, when working five machines—one is always kept as a standby—an area of 3,000 sq. ft., exclusive of melting and facing-sand preparing plant, produces 1,850 moulds per day or nearly two-thirds of a mould per sq. ft.

The attitude of the management towards wasters is that their reduction is of prime importance as giving added production free of cost. In other words, any gain goes straight into the profit account.

Fig. 2.—Part of the Mechanised Section of the Foundry. There are Two Roller Paths for each Machine, a Common Pourway and a Return Path through the Sand Bin.

Fig. 3.—At this Position the Cast Moulds are Stripped, and the Backing Sand is Reconditioned and Rendered Available to the Machine Moulders.

Fettling.

The castings are transferred to the fettling shop, where they are cleaned by packing in a Badische-Smeeton sand-blast barrel, or ordinary rumblers, provided with dust exhaust, after which a battery of grinders completes the operation.

Fig. 4.—The Loose-Pattern Section of the Foundry. Continuous Casting has Minimised the Amount of Floor-Space required by each Moulder.

We wish to acknowledge our indebtedness to Mr. Wynn, the works superintendent, for help accorded us in the preparation of this article.

Enterprise in Motherwell.

The Motherwell Iron & Steel Company, Limited, realising that the depression in the industry is passing, have broadened their activities and installed a new sheet mill, which replaces the billet mill, part of a wartime emergency equipment, which has been inoperative for some years. The company is also modernising its bar-mill equipment, the reconstruction in that department approaching completion.

By pressing a button the Marquis of Douglas and Clydesdale on May 26 set the machinery of the new mill in motion. He was introduced by Mr. A. Victor Wilson, chairman of the company, who sketched the history of the works and stated that, although the shareholders had not received a dividend for nine years, the average number of employees was over 200. Costs had been lowered substantially, but, unfortunately, the selling price had fallen consistently at a quicker rate. It was always a question, especially in difficult times, Mr. Wilson said, whether it was wise to spend the resources of the company in development of this kind. The experience of trade generally had been that more causes were lost through lack of enterprise than through courage. The new mill should have the effect of enabling the company to tackle a much wider range of business, and to deal with the very diverse specifications which are a feature of the present period.

The number of customers was constantly increasing, but the volume of purchases and the magnitude of the orders constantly fell. The comparatively large variety of the company's products, to which it was prosed to add an electric conduit plant in the near future, ensured that no matter what the final state of the steel-trade development was, the Motherwell plant would not be ignored and the employment it afforded would not be lost in the district.

The Marquis of Clydesdale remarked that the cause and cure of trade depression provided room for controversy, but it would be accepted generally that confidence was an essential, and confidence in industry was not to be obtained without courage and enterprise. In its new undertaking the company had shown that it possessed the qualities which should not only inspire confidence but should achieve success.

Provost Anderson, of Motherwell, presented the Marquis with a standard lamp in the name of the directors.

A Novel Drying Stove.

We never remember seeing in any foundry, either British or foreign, a vertical continuous drying stove, though we have read about single-chamber installations in America, so naturally we appreciated the opportunity of inspecting the first of this type, designed by Mr. W. H. Smith, a director of The Foundry & Engineering Company (West Bromwich), Limited, and erected in that firm's foundry at Sandwell Road, West Bromwich. This concern fortunately possesses a well-filled order-book for the manufacturing of the heavier type of castings for the automobile industry, so that the stove is being operated under thoroughly practical conditions.

Owing to its situation in the corner of the foundry, it is virtually impossible to obtain a really adequate photograph of the installation, but by correlating Figs. 1 to 4 a good general impression of its appearance and functioning will be gained.

Underlying Principles.

The general underlying principles of the stove are indicated in Fig. 1, which shows that plates carrying the moulds, or cores, are placed on to swivelling racks. These are carried through the stove by a chain-belt conveyor. Primarily, the cores are carried to the top of the first compartment and down again. This heats the work up to drying temperature, and gets rid of a proportion of the moisture. Then, similarly, they pass through the second compartment, where they receive a fresh supply of hot dry air, which, in the case of oil-sand cores, oxidises the linseed oil and effects a thorough baking. On leaving the second chamber the cores pass beneath a cooling canopy, and in this connection one can imagine that for certain large foundries this section of the conveyor would be prolonged so as to take in inspection, and, may be, blacking. Similarly, at the charging end, a prolongation of the conveyor would probably help with the efficient organisation of the core shop, by placing a larger number of coremakers in close proximity to the stove. The casual observer, familiar with foundry practice, is bound to be impressed by the working conditions. He cannot help noticing the complete absence of smell from the cooking of the cores. This feature, if badly controlled, often causes the eyes to run and the throat to be irritated. A second feature is the low temperature of the stove-casing, which, again, makes for comfortable working conditions, whilst, of course, indicating economy through elimination of "furnace losses" by conduction. The whole drying operation is controlled by regulating the two dampers shown at the centre base of Fig. 1. The fuel used in the actual furnace inspected was coke, burnt in an Acme furnace, which has been successfully applied to core and mould drying in conjunction with stationary furnaces by the industry for some time. It works on a forced-draft principle and gives a continuous flow of hot, dry air, whilst maintaining a slight positive pressure in the stove served.

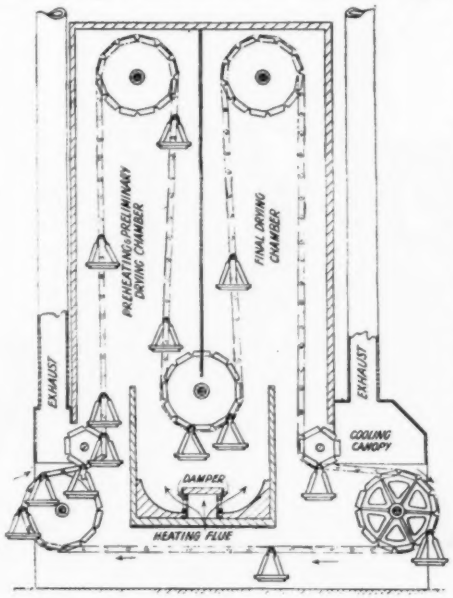


FIG. 1.—A SECTION THROUGH THE ACME CONTINUOUS CORE-DRYING STOVE.

A salient feature is obviously that of space occupied in relation to the number of cores produced per unit time. This calculation can only be worked out by each individual foundry, and for this purpose we submit the following data. The stove occupies a floor space of 15 ft. by 6 ft. (its extreme overall height, by the way, is 18 ft.), plus 4 ft. by 3 ft. taken up by the small Acme furnace situated at the side, as shown in Fig. 3 (the exit end of the furnace).

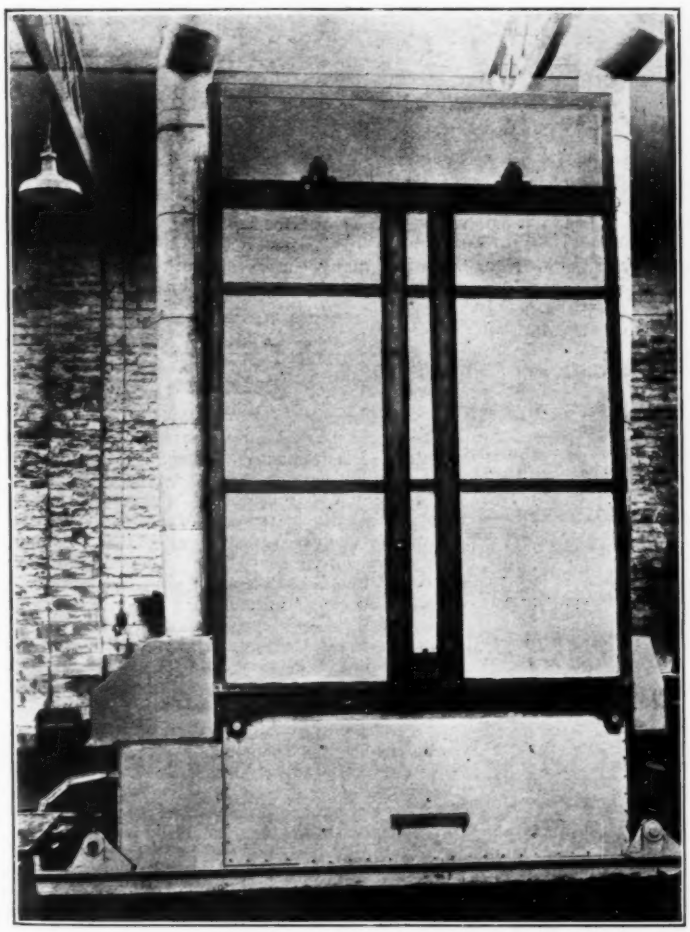


FIG. 2.—A SIDE VIEW OF THE STOVE.

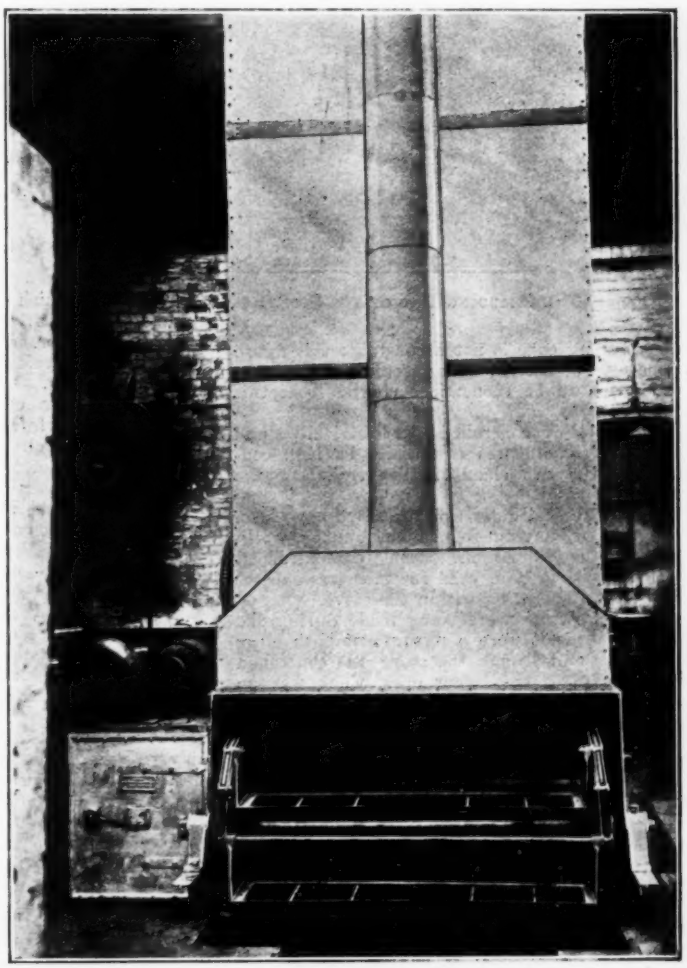


FIG. 3.—THE DELIVERY END OF THE STOVE, SHOWING THE SMALL ACME FURNACE AT THE SIDE.

Thus, with a total superficial area of 102 sq. ft., the daily output of 8½ hrs. is 1,150 plates measuring 27 in. by 14 in. carrying oil-sand cores up to 2-in. section, the actual stoving time being 48 min. If each plate carries but two cores, more than 20 cores are baked per sq. ft. per day. If larger-sectioned cores are carried through using backing sand instead of shell carriers, then about 700 of these plates go through per day, as they require 75 min. stoving.

It will be realised from the above statement that the speed of the passage through the oven can be varied. Actually, for this purpose, a set of change-gear wheels is provided and used exactly as on a lathe, taking 3½ min. to set. For their actuation and for providing the blast for the small furnace, a motor taking less than 1 h.p. is used. The coke consumption on this particular plant is stated to be 4½ cwt. per

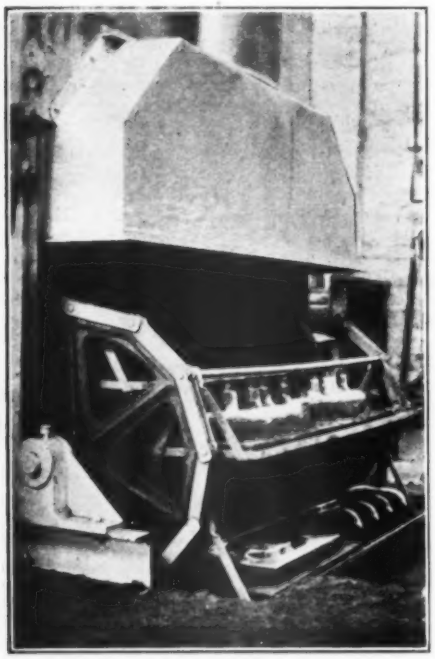


Fig. 4.—The Charging End of the Stove.

diem, but, as coke is not a constant, this figure is merely indicative; in any case it shows the installation to be economical viewed from this angle.

The stove is controlled pyrometrically, and different temperatures can easily be held constant in the two chambers by regulating the dampers.

The mechanical details of the stove have been well studied, having regard to foundry working conditions, and nickel-chrome case-hardened steel parts have been used for members subject to wear and operating within the stove.

The cores which were being made during the time of our visit were a mixture of both large and small, and though the stove was controlled to take care of the larger ones, there was no sign of burning the sharp edges of the smaller variety, a useful feature capable of taking care of change in the nature of production involving the mixing of core sizes.

Application for Patent rights has been made in all the principal manufacturing countries.

The Hunslet Engine Company, Limited, Leeds, have received a contract from Messrs. John Mowlem & Company, Limited, for eight locomotive engines, 0-6-0 type, with 14-in. by 20-in. cylinders, for use on the contract for the building of the new graving dock at Southampton. His Royal Highness Prince George visited the Hunslet Engine Works on Wednesday and saw the first of these engines completed and ready for despatch.

A New Design of Sand-Blast Room.

Any improvement in the general design of sand-blast plant will certainly be of interest to the foundry industry, especially when it tends to reduce the cost of production and also to improve the working conditions from the hygienic point of view. In the ordinary type of sand-blast room the work is carried into the room, sand-blasted and then returned to the main shop. This naturally takes up quite an appreciable amount of time during which the sand-blasting operation is stopped. In a new design of Gutmann plant recently placed on the market by T. Fearnley, Allen & Son, of 20, Norwich Union Chambers, Birmingham, and shown in the illustration, a turntable is fitted which is half in and half out of the room, the object being that whilst the operator is sand-blasting work on the half that is inside the room another man is removing the cleaned castings and substituting others for blasting, or, in the case of heavy castings, which are more than the operator can handle himself, these can be turned over either by hand or by an overhead crane. It will be seen, therefore, that the operator can work continuously.

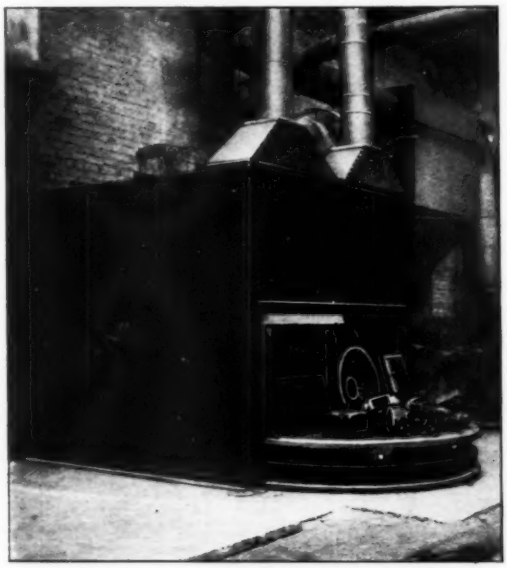


Fig. 1.—The New Gutmann Sand-Blast Room.

The construction of the table itself is of a C.I. or M.S. perforated plate mounted on a centre casting which is fitted with a ball race; across the centre of the table a sheet-iron division plate strengthened with angles is mounted which, when the table is in a working position, seals the end of the room. The table is generally revolved by hand, though mechanical means can be adopted if necessary, through an angle of 180 deg.

Undoubtedly there are many points of advantage in this type, of which the following appear to be the most outstanding:—

(1) Increased production, associated with lower running costs, owing to the fact that there is no idle time.

(2) The area of the main room can be appreciably reduced, as it is only necessary to allow sufficient room for the operator to stand in front of the table. The power costs are lower, as the capacity of the exhaust fan can be reduced.

(3) Owing to the smaller area and the fact that the operator is more or less stationary the dust-exhaust arrangements can be made more efficient, thereby allowing the operator to work in a cleaner atmosphere. From an actual test taken from the time of opening the door of the room after sand-blasting had taken place, a period of 35 seconds was sufficient to leave the atmosphere perfectly clear of dust. The dimensions of the room in this particular case were approximately 9 ft. × 9 ft. × 8 ft. high.

(4) Under the Home Office silicosis regulations any man working in contact with sand-blast plant comes under the Act. With this design, as the opening of the doors for loading and unloading the room is not now required, only the operator himself is affected. There is a considerable future for this type of plant, as undoubtedly a very much greater output can be obtained than in the case of the ordinary room, and in these days, when so much attention is quite rightly called to the improved conditions for the operator, it has great advantages.

A somewhat similar type can be constructed embodying the system of the half-in and half-out table by allowing the operator to work outside a cabinet in place of inside a room. This design, whilst being more perfect from the hygienic point of view, does not lend itself so readily to the sand-blasting of intricate castings, as the range of the man's arm is limited by the opening in front of the cabinet. There are, however, many classes of work which can very well be treated in this manner.

A French Foundry Research Institute.

The Société des Hauts Fourneaux de Saulnes (Saulnes Blast-Furnace Company), a nuclear concern with which a large number of foundries are connected, has organised a research department, under the patronage of Mr. León Guillet and under the direct control of Mr. Le Thomas, who has in recent years been connected with the French Admiralty Dockyards and the Piat concern. The new organisation will carry out researches into cast iron with the object of improving normal technique and new applications. It will supply experts for the perfecting of new types of manufactures or solving difficult problems. It will collect and classify existing information on pig-iron and foundry matters and create a development department for ensuring the industrial application of the results of scientific research. It is to do this by publishing a bulletin, by personal contact, by correspondence and by furnishing experts. The bureau of information will be centred at 18, rue de La Boetie, Paris, whilst active research work will be carried out at Saulnes. The nature of the personnel ensures that the work undertaken will be free from any trade bias, and its sole object is to give the foundry industry a truly scientific and technical service.

XUM

Cast Alloys for High-Temperature Service.*

By Professor D. Hanson (University of Birmingham).

Theory Underlying the Use of Metals at High Temperatures.

It is only within comparatively recent times that metallic alloys have become available, capable of being used for prolonged periods at high temperatures. Until about two years ago, iron and steel were the only industrial materials capable of being used at a red heat, and their life was usually very short. For sustained service at these temperatures, refractories of some kind were the only materials available, and these cannot, of course, be utilised in mechanically-operated appliances or in situations where they have to withstand tensile or bending stresses. Notwithstanding their serious limitations owing to lack of strength and chemical and physical deterioration, enormous tonnages of iron and steel were used; in most cases their life was short, and they failed rapidly through oxidation. Even at the present time, ordinary steels and cast irons form by far the largest proportion of metallic materials employed at high temperatures.

Rapid engineering developments within recent years have revealed the inherent weaknesses in these and other alloys when subjected to great heat, and have led to a demand for better materials for a whole host of purposes. The development of turbines, high-pressure boilers, high-temperature super-heaters, chemical processes involving reactions at high temperatures, and improved high-temperature furnace equipment of all kinds, have demanded new materials, and are to-day making it necessary for the metallurgist to put forth all his efforts to cope with these needs. In many directions, in fact, the engineer is asking for more than can at present be given him, and important engineering developments in certain directions only await the development of the right materials.

The chief requirements for materials for service at high temperatures may be considered under two headings:—(1) Mechanical strength, and (2) chemical resistivity. For some applications the strength considerations are of first importance, but in the majority of cases, though strength at high temperatures may be required, chemical stability under the conditions of service is all-important. It will be useless to select an alloy which, though adequate in strength at the outset, would rapidly weaken through oxidation or wastage under the conditions of service, and adequate chemical resistivity is, therefore, in most cases, the principal requirements.

Chemical Resistivity at High Temperatures.

Any metal or alloy is chemically resistant at high temperatures only with reference to the particular conditions under which it is used. In this respect resistance to heat is very similar to resistance to corrosion, which, as is well known, is not an absolute quality of an alloy, but can only be defined with reference to the corroding agent. Thus, a so-called stainless steel, which is highly resistant to atmospheric and many other kinds of corrosion, is rapidly attacked by sulphuric acid, to which its resistance may be less even than ordinary carbon steels. Exactly the same qualifications must be applied to the term "heat-resisting material" as are commonly applied to "corrosion-resisting material." Thus, tungsten could be considered as highly resistant to heat in an atmosphere of nitrogen or hydrogen. Tantalum would be highly satisfactory in hydrogen, but not in nitrogen, while neither would be as resistant as ordinary cast iron if exposed to ordinary air. These are extreme examples, but will serve to illustrate the point that it is not possible to describe any particular alloy as the best, or even as a good heat-resisting alloy, without reference to the conditions under which it is to be used.

Under ordinary industrial conditions, resistance to oxidation at high temperatures is most commonly demanded, but even with this simplification, many factors may enter into the problem, for oxidation may be induced by a variety of conditions which may vary in their importance according to the alloy used. In spite of the above limitations, one may nevertheless attempt some general analysis of the whole question. Surface stability in metals and alloys at high temperatures may be due to: (1) Intrinsic inertness under the conditions of exposure, and (2) the formation of adherent impervious layers of reaction product between the alloy and the corrosive environment, which prevents further action.

Perfect examples of inherently inertness are only to be found in the noble metals—gold, silver and the metals of the platinum group. These do not form oxides on heating, even for very long periods at high temperatures, and they thus possess heat-resisting properties of a high order on account of their chemical stability. The pure metals themselves are, of course, mechanically soft, but doubtless heat-resisting alloys of the highest quality could be developed by alloying, if it were not for their prohibitive cost.

All the common metals of commerce are reactive in that they form oxides when exposed to air at a high temperature; from the chemical point of view their reactivity is in most cases quite high, and under suitable conditions any one of them could be rapidly turned into its oxide. For example, any of the common metals, if prepared in a finely-divided state, and exposed to the action of air at high temperatures, would rapidly change over entirely into the oxide. In practice, however, chemical reactivity is far less important than the nature of the reaction-product, and some of the most reactive metals possess a degree of resistivity to heat that would never be anticipated from their chemical properties alone. Aluminium and chromium, for example, judged by all chemical standards, are very easily oxidised, and their oxides are among the most stable products known to man. They are, however, heat-resisting to a high degree, for the reason that the oxidation product forms a tenacious, adherent, continuous film which acts as a highly efficient protecting layer and shields the underlying metal from contact with oxygen.

The Scaling of Iron.

Iron and copper are chemically much less reactive, but the oxidation product is very much less protective, and permits oxidation to proceed at such a rate that neither of these metals alone can be regarded as heat-resisting. The work of Pfeil has thrown much light on the process of oxidation in the case of iron, and he had clearly demonstrated how this metal deteriorates under heat. The layer produced in this case may consist of three oxides which possess a definite solubility for iron. Oxidation continues because diffusion inwards of oxygen and diffusion outwards of iron can go on continuously through this layer at a rate that leads to the rapid production of scale. Nickel and cobalt possess intermediate properties between those of the above two groups. In regard to their chemical properties, they are rather similar to iron and copper, but under ordinary conditions of oxidation the films of reaction product have superior protective qualities.

It is a feature of the metallic constituents in alloys that they appear to confer something of their own particular properties on the alloy, and this is especially true in regard to resistance to oxidation. For example, the incorporation of aluminium or chromium markedly increases resistance to oxidation in the cases of metals such as iron or nickel; nickel increases the resistance to oxidation in the case of iron and copper, and so on. The mechanism of this protective action is as yet far from understood, but it is undoubtedly due to the influence of the second metal on the nature of the film of reaction product. Pfeil's studies of iron scale have demonstrated this in a very clear manner. A nickel steel is less readily oxidised than an ordinary steel, for the reason that the nickel is reduced to the metallic state in the scale, in which it appears to be completely insoluble; it is unable to diffuse continuously, and thus accumulates on the inner surface of the oxidised layer, where it offers a mechanical hindrance to the normal process of oxidation. In the same way, chromium in an iron alloy becomes concentrated in the inner layers of the scale, in this case, as an oxide, its protective action thus becoming greatly enhanced, even though it is only a minor constituent of the alloy. As yet, we know far too little of the exact processes by which these scales are formed, but enough to realise that heat-resisting alloys depend for their permanence mainly upon the nature of the layer formed on the material in service. Under practical conditions the rate of high-temperature deterioration may be greatly affected by the presence of other substances—sulphur compounds, acid or alkaline vapours or salts, etc.

Mechanical Strength at High Temperatures.

It is quite clear that for engineering purposes something more than thermal stability is required, and that the materials used must possess suitable mechanical properties. For many applications a high degree of mechanical strength is required, and a consideration of the general question of mechanical properties at high temperatures is therefore necessary. In the first place, considerations of melting point alone exclude some of the metals. For example, although aluminium alloys are heat-resisting to a high degree at temperatures quite close to their melting points, they are clearly not capable of being used for many industrial purposes, for the reason that they melt at too low a temperature. Furthermore, since mechanical strength in practically all alloys falls off very much as the melting point is approached, it is desirable in practice, where a maximum strength is required, to use an alloy whose melting point is substantially higher than the maximum operating temperature. Of the common metals very few have melting points sufficiently high for them to be considered suitable materials as the basis for high-temperature alloys. Copper melts below 1,100 deg. C.; most copper alloys are partially or completely liquid at substantially lower temperatures and few alloys, of which copper is the principal metal, are suitable for use at temperatures above 600 deg. C., beyond which they are all very weak.

Iron and nickel are the common metals possessing a combination of high melting-point and good mechanical strength, and these are natural basis materials for alloys subjected to high-temperature conditions. In all respects except that of cost, iron is inferior to nickel; it becomes weak at a lower temperature and is rapidly oxidised, even at a dull red heat, while the oxide coating affords only a small degree of protection. Nevertheless, its high melting-point and low cost ensure for it an important place as a constituent of the heat-resisting alloys. Nickel is undoubtedly the most important basic material for alloys in which the maximum resistance to high temperatures is required. It is stronger than iron, and even without alloying possesses very considerable resistance to scaling at high temperatures. The proper development of alloys of this metal should afford, in the near future, materials of the highest quality for high-temperature service.

It will be of interest to give a little consideration to the principles of alloying in rela-

D

* An address given before the London Section of the Institute of British Foundrymen, Mr. A. F. Gibbs presiding.

tion to mechanical strength. Alloys are usually stronger than the pure metal from which they are formed. When one metal enters into solution with another in the solid state, the strength of the solid solution usually increases with the amount of the dissolved metal, so that, where the metals are completely soluble in one another, the maximum strength, usually, is found in an alloy having roughly 50 per cent. of each metal. In most instances metals are not completely soluble in one another, and in such a case the maximum strength is usually obtained when the limit of solid solubility is reached. It is, further, true that a strong metal with a high melting-point usually exerts a greater hardening effect than a soft metal with a low melting-point, and one would therefore naturally turn, when possible, to the strong, high-melting-point metals as alloying constituents for heat-resisting alloys.

In other instances when a metal is alloyed with another metal, or sometimes with a non-metal, definite chemical combination ensues; in such instances the mechanical properties of the compound so formed bear little or no relation to those of the constituent metals. Such compounds are usually hard and brittle, though they frequently retain their strength very well at high temperatures, particularly when their melting-points are relatively high, as is quite often the case.

Strengthening and Protecting Metals.

Most of the commercial heat-resisting alloys are of the solid-solution type, and their strength at high temperatures is primarily due to the solution of one or more metals in solid solution in the base metal. Their chemical stability also is due to the suitable choice of alloying metals, which will, under the conditions of service, build up an effective, protective film. Broadly speaking, the strengthening metals are nickel, iron, copper, tungsten, molybdenum and similar elements which are themselves strong; the protecting metals are aluminium, chromium and silicon, which, though themselves chemically reactive, have the capacity, when present in sufficient quantity, of building up a protective oxidised layer.

It is now quite clear that the only metals which can form the major constituents of heat-resisting alloys capable of being manufactured in large tonnages, are copper, iron, nickel and possibly cobalt, if the last-named can be obtained in sufficient quantities and at a suitable cost. These metals must be rendered suitable for such services by further alloying on the lines previously indicated. Developments along these lines have been made for the most severe conditions of service, but it cannot be doubted that much further progress is possible, and that further investigation will lead to materials of greatly enhanced properties at high temperatures.

Futility of Accelerated Tests.

The rapid decrease in strength as a metal is heated up is not sufficiently appreciated by many engineers and designers, and more particularly by the users. It is not sufficiently recognised that the time factor becomes predominant above a certain temperature, which varies from alloy to alloy, and that within the higher ranges of temperature, tests carried out in a short time give no indication of the strength of the same materials under a prolonged load. Still more is it true that tests carried out at room temperature are inadequate for estimating strength at elevated temperatures. It is, of course, obvious that strength due to cold working will not be maintained above the recrystallisation range, but it is not always sufficiently realised that a material which owes its strength to some form of heat-treatment, such as tempering and quenching, must lose this additional strength if it is reheated to a sufficient temperature. For example, a heat-treated steel may be classed as an exceptionally strong alloy at ordinary temperatures, if the heat-treatment has been properly adjusted, but at a red heat, all effects of the heat-treatment will be obliterated, and the material be no stronger than one which at room temperature was in the annealed condition. Moreover, the removal of strength, due to heat-treatment, is also a process that can occur at quite low temperatures if the heating is prolonged. It is therefore clear that for high-temperature service, reliance cannot be placed on strength due to heat-treatment.

In general, the strength of an alloy falls as the temperature is raised. In the case of metals such as iron and nickel, this fall is usually slight up to a temperature of about 400 deg. C., beyond which it becomes rather rapid. Some of the stronger alloys maintain their strength to higher temperatures, but in all cases, as the temperature is further increased, the strength falls rather rapidly and becomes very small indeed in the region of the melting point. The physical properties at high temperatures of such metals as iron and nickel, or the so-called heat-resisting alloys, would be better understood if one considers that as the temperature rises they change in their general characteristics to resemble first copper, then aluminium, then lead, and, finally, mercury, as they pass the melting temperature. Much work has been done on the variation of tensile strength with temperature for many materials. In the case of a mild steel, for example, having a tensile strength of 30 tons per sq. in. at room temperature, the strength at 300 deg. C. is hardly altered, and at 600 deg. C. has fallen to about 10 tons per sq. in. These are the results obtained in a test carried out at normal speed. If, however, tests are carried out very slowly, and the load is measured that will only cause the metal to break after about one year instead of a few minutes, the strength at 300 deg. C. is found to be only about 10 tons per sq. in., and at 600 deg. C. less than 1 ton per sq. in. The figure taken to be the strength is, therefore, very much dependent upon the time taken to carry out the test. Of course, the figure that is of most significance in respect of alloys for use at high temperatures is the figure resulting from the second type of test, that in which the material is tested slowly.

Incidence of Plasticity.

Another respect in which metals at high temperatures differ from metals at low temperatures is that at high temperature they have practically no elasticity. Metals at high temperatures begin to flow even when subjected to very low loads. That flow may continue for a time and then cease, and after that the metal may stand up indefinitely; or, after a period during which the flow has been very slow, it may begin to increase again and the metal may break. This capacity for flow is an important factor in regard to the use of metals at high temperatures, because it is quite clear that the amount of flow that can be permitted in metal applied to any particular service will be limited; service conditions will permit alloys to be distorted by more than small amounts, otherwise they fail to achieve the objects for which they are being used. Flow must be so limited that it is not harmful during the useful life of any particular part. Most of the heat-resisting metals have a useful life under load, provided the deformation is so small that it can be disregarded for practical purposes, but nearly all of them do flow to a slight extent in use, as is shown by careful measurement.

One other property of metals which ought to be referred to in connection with heat-resistance —though it is not usually dealt with—is that of thermal expansion and contraction. There can be very wide fluctuations in temperature between atmospheric temperature and the high temperatures under consideration, and there may be very great differences of temperature as between the different parts of an article in service. These differences of temperature can cause stresses, and, in view of the very low elasticity of metals at high temperatures, these can give rise to flow.

Thermal Expansion.

Consider for a moment the kind of stress that may be set up by thermal expansion. In ordinary structures, at ordinary temperatures, quite small variations in temperature sometimes cause very serious distortion. For example, reinforced-concrete structures may quite easily be cracked if they attain uneven temperatures. There are the well-known instances of rails, bridges, and so on, in the design of which the thermal expansion has to be allowed for; somewhere there must be freedom of movement if buckling is to be prevented. In alloys used at high temperatures, however, the possibilities of stresses, due to different degrees of thermal expansion in different parts are much greater, and constitute a distinct factor to be overcome in connection with high-temperature work. Moreover, this expansion and contraction is a function of the metal, and the expansion and contraction of the protective layer of oxide on the metal may be quite different from that of the metal itself, so that the protective layer might quite well be broken down by the thermal expansion and contraction stresses alone. That is very well borne out by many tests on heat-resisting alloys. If an oxidation test is carried out on, say, a sample of ordinary electrical-resistance wire by heating it to an appropriate temperature and measuring the increase in weight, it is found that it is very resistant indeed, provided that that temperature is maintained; but if it is heated and cooled alternately, so that it is subjected to rapidly-alternating temperatures, its life is very short indeed, for the simple reason that the scale cracks up, due to the expansion and contraction stresses, and allowing the oxide to penetrate it and deteriorate the metal. Such a test is now used, because it is the only type of test that has relation to service conditions.

Where Castings Equal Wrought Material.

Whilst this address refers to casting alloys, it may be thought that most of what has been said applies to heat-resisting alloys in general, and that is true. But there are certain features about castings in relation to high-temperature service which must be referred to. It is not necessary to refer at length, in the presence of members of the Institute of British Foundrymen, to the special advantages of castings over wrought forms—the ease of making intricate sections and so on; but there are other features of castings with which perhaps founders are not quite so familiar. For ordinary purposes, wrought materials—rolled sections and so on—are generally superior to castings, and often very much superior; this is due chiefly to the fact that the wrought forms possess the quality of elasticity: it is that property which distinguishes, more than does any other, the wrought product from the cast product. If elasticity does not exist in the annealed material, it can be induced by processes of working, but that cannot be done with castings. But at high temperatures the wrought materials, as well as the cast materials, lose their elasticity, so that the two achieve a much more equal footing; the rolled materials are no longer able to resist high stresses without deformation, or with only the slight elastic deformation which would occur at lower temperatures, so that one of the principal advantages of these rolled materials disappears when they are subjected to high temperatures.

Heat-resisting alloys are likely to be rather different from the usual alloys used for rolling and forging. A heat-resisting alloy is one which should be very strong at high temperatures. Naturally, that requirement involves a large amount of stiffness and so on—just the sort of qualities which are not desirable in a material which is to be forged or rolled; there a material is needed which will have strength at low temperatures, but which will be capable of reasonably easy handling at high temperatures. If strength at high temperatures in heat-resisting

alloys is essential, a rather different material is sought. There, again, a distinction between the wrought form and the casting is obtained.

There is another very important condition relating to castings. Castings are much more stable than the wrought forms; castings are not subject to the kind of grain growth and recrystallisation to be associated with rolled metals. If a section is carefully cut from a casting, polished and then etched to reveal the structure, and one tries to recrystallise it or make the grains grow by annealing, no success will be achieved. The only conditions in which the author has seen it done are those in which, during the cutting, the metal is worked sufficiently to make it recrystallise; the unworked casting is very stable from the point of view of structure, and unless there are transformations in it the crystal structure is not easily modified under heat. Secondly, it has been found recently that castings, under creep conditions, *i.e.*, under conditions of exposure to stress for very long periods at high temperatures, are actually stronger than wrought materials. Instances of this are now numerous.

It has been experienced personally in the course of experimental work on aluminium alloys; it is reported in the cases of a number of nickel alloys, including the chromium-nickel alloys; and many of the experiments at the National Physical Laboratory confirm that the castings are actually stronger than the wrought materials in this high-temperature range. Thirdly, the rate of flow—and they all flow a little—of cast materials is much less than the rate of flow of the wrought materials.

These benefits may be due to the large crystal size, because it seems to be a fact that the finer the grain at the low temperatures the more readily do they flow. Be that as it may, however, there is the fact that the casting does not suffer from the same disabilities at high temperatures as it so often does suffer from at ordinary temperatures. There is another factor which is in favour of the casting. It is that where high ductility and easy machinability are not asked for—and there are many such applications—it is possible to secure in castings a remarkable degree of strength and hardness at high temperatures, far exceeding that which can at present be attained in wrought forms.

Available Alloys.

Reviewing some of the alloys that are available and considering how they fit in with the general account given of the theory, it is proposed primarily to deal with materials intended for use at very high temperatures—say, 600 deg. C. and above. Copper alloys would be used at temperatures lower than that, but it is not intended to say much about the copper alloys. Copper itself is very weak. The ordinary alloys, such as the bronzes and brasses, which contain as alloying elements zinc and tin, which have low melting points, are not strong at high temperatures, nor are they resistant to oxidation. The copper alloys that are strongest at high temperatures contain strengthening metals, such as nickel, iron or silicon, which are themselves strong and which have high melting points. For resistance to oxidation there are aluminium (one of the reactive protecting metals) and silicon (which improves the resistance to oxidation very appreciably and increases the strength). Chromium does not alloy very readily with copper. It is not known what would happen if it could be alloyed satisfactorily with copper, but, as a rule, one cannot get enough chromium into copper to be able to take advantage of the benefits which it might be expected to give.

The next group which is to be considered—and here the true high-temperature-resisting alloys are being dealt with—is the group which has iron as its base. First of all, of course, there are the simpler alloys—the ordinary steel and cast iron—for, when all is said and done, from the tonnage point of view these are still the principal high-temperature-resisting materials. The strength is maintained fairly well until a temperature of about 300 deg. C. is reached; then it begins to drop away, and becomes very low when temperatures of 700 and 800 deg. C. are reached. A 0.2 per cent. carbon steel has a strength of 31 tons per sq. in. at ordinary temperatures, 27 tons at 300 deg. and 10 tons at 600 deg., as determined by accelerated tests. When subjected to the creep test the strength is 9.9 tons at 300 deg. and 0.89 tons at 600 deg. Thus, at the latter temperature it has lost nearly all its strength. In the case of a 0.36 per cent. carbon steel there is practically the same state of affairs; the low-temperature strength is a little higher than in the other case, but there is practically no difference in regard to high-temperature strength. The strength of steels can be increased to some extent by alloying, and attention is drawn to the alloy steels—not those which are called heat-resisting. Steels can be improved by moderate alloying. For example, an ordinary high-tensile nickel-chrome steel, containing 3 or 4 per cent. of nickel and about 1 per cent. of chromium, is very superior to a similar steel containing no alloying elements. At a temperature of about 175 or 200 deg. C. the strength is 21 tons per sq. in., as compared with 13 tons in the plain carbon steel, and at 590 deg. C. the strength is more than double that of the plain carbon steel. Thus the possibilities of getting distinctly better service, as the result of moderate alloying, in high-temperature work, are evident, and, of course, both the nickel and the chromium also have the effect of increasing in a moderate degree the resistance of the metal to oxidation at high temperatures.

Cast Iron as a Heat-Resisting Material.

Cast irons maintain their strength to a higher temperature than do the steels, as indicated by the ordinary rapid test. In most instances there is no sign of a reduction of strength until a temperature above 400 deg. C. is reached. That is no doubt due to the fact that cast iron is not nearly such a pure metal as steel, and possibly the improved properties are to be attributed mostly to the presence of silicon, which is normally present in substantial amounts. Cast iron, of course, is the kind of material that one would wish to use wherever possible for high-temperature service, because of the ease with which it can be manipulated, and also because of its cheapness. Although its strength in relation to that of steel is quite good, however, it suffers from the complaint known as "growth." At high temperatures cast iron swells, as the result of internal oxidation, and, after exposure, it may occupy very substantially greater volume than it occupied previously. There are many factors which influence growth, and perhaps the dominating one, so far as structure and composition are concerned, is the condition of the graphite. A high total-carbon content and a coarse graphite structure will favour growth; a low total-carbon content and a close graphite structure will reduce or hinder growth. A second factor, which is also of importance, is the existence of a "critical range." The rate of growth is very much increased if the iron is heated and cooled alternately. That factor is connected with the volume changes set up when the iron passes through the critical range of temperature, and is really due to a form of thermal expansion—the stresses set up by the thermal expansion help to disintegrate the metal. A really satisfactory heat-resisting cast iron must not grow. Two principal methods of attaining this result suggest themselves. One is to get rid of the coarse graphite structure; that involves, among other things, ensuring that the iron has a low total-carbon content. The second point is that the critical change must be avoided.

Alloyed Cast Irons.

There are at least two methods by which the critical change can be avoided. Two elements have a very profound effect upon it. The first of these is silicon, the effect of which is to raise the critical points; if sufficient silicon is added it results in their disappearance, so that the iron may be heated from ordinary temperature right up to its melting-point temperature without changing its condition. The British Cast Iron Research Association has evolved irons in which the improved heat-resisting qualities are due to silicon. For high-temperature work the Association is recommending an iron containing roughly 5 per cent. of silicon and a low total-carbon content. This is rather hard, and it is understood, although it can be machined, it is not so easy to machine as is ordinary iron. It is also rather brittle, but it is learnt that it is giving very greatly improved results—though no personal experience of it has been possible, because it is a new material. The second element the use of which will enable one to avoid the critical change is nickel, which acts in a manner different from silicon. Nickel depresses the critical points, and if it is present in sufficient quantity it will reduce the temperature of the change right down to atmospheric temperature, or below, so that the change does not occur. Whereas silicon transforms the iron into the ferrite condition, nickel preserves it in what is known as the gamma iron, or the austenitic condition. In the latter condition iron is soft, and is very easy to machine; in fact, it is more like a non-ferrous metal than an iron from this point of view. Irons of both these types resist growth much more effectively than does the ordinary cast iron. The nickel-containing iron has usually a little chromium also, perhaps from 2 to 4 per cent., and some copper, and it has very good heat-resisting properties. It is almost free from growth, and its strength is very well maintained at high temperatures. This iron has been developed by Messrs. Monel-Weir, Limited, under the name of "Nimol." It is finding very useful applications in quite a number of directions.

Nickel-Iron-Chromium Alloys.

All the high-grade heat-resisting alloys—for the cast irons are not in the highest grade of the heat-resisting alloys—are made up with an iron base, or a nickel base, or, in some instances, a base of an iron-nickel alloy. Chromium is, without doubt, the important metal in high-temperature alloys, because more than any other it confers the property of resistance to oxidation. It has also quite a considerable strengthening effect, and altogether it is a most useful material. The ordinary stainless steels, containing about 13 per cent. of chromium, are quite good heat-resisting alloys. In comparison with some other materials their high-temperature strength and heat-resistance properties are, perhaps, only moderate, but they are quite good at temperatures below about 900 deg. C., and, of course, they can be made in the form of castings. At least 16 per cent., and preferably more, of chromium is required to give the highest degree of resistance to oxidation at high temperatures, and practically all the super-heat-resisting alloys contain at least that amount of chromium. Alloys having an iron base and containing chromium only as an alloying metal are coming more and more into use—as much as 30 per cent. of chromium is being added—and, moreover, these alloys cast very well. Although such materials have good properties, chromium by itself as the alloying metal is not quite good enough to give the best properties. The strength falls at the higher ranges of temperature—in the region of 800 or 900 deg.—unless something else is present with the iron and chromium.

Another class of alloys, containing nickel as a base and containing chromium also, is also commonly used for heat-resisting service. These alloys are marketed in this country under the name of "Brightray," "Cronite," "Nichrome" and other trade names. One type of alloy contains nickel and chromium alone. This is definitely superior to the iron-chromium alloys; at

high temperatures it has very high strength and good resistance to oxidation. The 80/20 alloy is particularly good. It has a high creep-strength, and at 800 deg. C. it will withstand permanently a stress of about 2 tons per sq. in.

Most of the heat-resisting alloys may be regarded as nickel-iron-chromium alloys, with or without additions of other metals. They can be regarded as alloys with a strong nickel-iron base, plus chromium to give resistance to oxidation; plus a little more stiffening, if they will stand it, by means of tungsten, molybdenum, silicon and a variety of other elements, to give them the maximum strength. The nickel-chromium-iron alloys vary rather widely in composition. Typical compositions range from 25 to 66 per cent. of nickel, 18 to 55 per cent. of iron, and 16 to 20 per cent. of chromium. A chromium content of from 16 to 20 per cent. appears to be a common feature of the best alloys of this type. They are all casting alloys; they possess some ductility—though in varying degree—and are very high-grade materials. In general, the higher the iron content the less is the resistance to scaling, and the chromium content must be limited in order to avoid undue hardness and to facilitate machining, so that usually the chromium content is rather less than 20 per cent.; in some cases it is below 16 per cent. All these alloys find wide application in numerous heat-resisting services where the highest quality of material is desired.

Recently the steels which are known as heat-resisting steels have been developed. These also may be regarded as nickel-chromium-iron alloys, containing also additions of other metals, and including a certain amount of carbon. These also are made in various compositions. One of the best known, which is typical of this class, contains about 35 per cent. nickel, 18 per cent. chromium and about 4 per cent. tungsten, plus 1 or 1.5 per cent. silicon and perhaps 0.5 per cent. carbon. The chromium renders the alloy resistant to oxidation at high temperatures, the nickel acts similarly and strengthens it, and it is further stiffened up by additions of elements of very great strength and very high melting-point, such as tungsten, silicon and carbon. This alloy has a creep strength of about 2.5 tons per sq. in. at 800 deg. C. Naturally, its ductility is rather low, and it is essentially a casting alloy, though it can be machined.

Some still more interesting alloys have been developed recently. Particulars in regard to them are published in a report from the National Physical Laboratory, and still more remarkable creep limits have been determined, in some cases up to 6 tons per sq. in. at 800 deg. C.—a truly remarkable figure. The alloy which has that strength is again essentially a nickel-chromium-iron alloy, containing 30 per cent. of nickel, 30 per cent. of iron, 33 per cent. of chromium, and being stiffened further by means of tungsten, silicon and carbon. Naturally, it is hard and brittle. It is thought that it cannot be machined, but has to be ground; nevertheless, from personal knowledge, it has the highest creep stress that has yet been reported. Attention to it is drawn particularly because of the big increase registered there—from a creep strength of 2.5 tons per sq. in. in the best of the commercial alloys to 6 tons per sq. in. in this (as yet) experimental alloy.

The possibilities are but barely indicated by these facts. Probably the future lies with casting alloys for the very high strengths. It is doubtful whether they will be obtained in materials which can be worked, but for service at the very highest temperatures it will be possible to produce castings having strengths not yet dreamed of. There are many possibilities not yet explored. The use of aluminium as an element conferring scale-resisting properties has been referred to; that matter has hardly yet been touched in relation to either nickel or iron-base high-temperature alloys. It seems highly probably that there are possibilities, in regard to the use of aluminium for improving scale-resistance, that are worth exploring; indeed, there has been an important development in that direction recently. Some of the nickel alloys suffer at high temperatures in the presence of sulphur gases, although they serve extraordinarily well under oxidising conditions. It has now been discovered that, by the addition of aluminium to nickel-chromium alloys, their resistance to the action of sulphur gases can be increased to an extraordinary degree. There, again, there is just the type of thing previously referred to—the use of protective materials to withstand particular conditions. If it is proved that in other alloys containing iron and nickel the use of aluminium, in addition to conferring resistance to oxidation, also confers resistance to the action of sulphurous gases, it is certain a particularly important development will have been made.

An effort has been made to review the principal factors influencing the strength and resistance of metals at high temperatures. The examples put forward are not so numerous as one would have wished, but they have been included in order to emphasise the underlying principles that their application may be appreciated.

A VOTE OF THANKS TO PROFESSOR HANSON.

Mr. H. C. Dews (Senior Vice-President of the Branch), who proposed a hearty vote of thanks to Professor Hanson for his lecture, emphasised that the subject of cast alloys for high-temperature service was becoming increasingly important, inasmuch as the temperatures used in all fields of engineering appeared to be increasing. For example, steam temperatures—with which he was particularly concerned—had increased during recent years from about 700 deg. F. (which was at one time considered to be a very high temperature) to 1,100 and 1,200 deg. F. In furnace work and in other branches of engineering also, alloys were required to withstand increasingly high temperatures.

Discussing the lecture, Mr. Dews said that Professor Hanson would be the first to admit that one must not argue too strictly from his general remarks to the particular, and there were one or two instances which appeared to call for that reservation. He thanked Professor Hanson for having pointed out that, for high-temperature service, the cast alloys were demonstrating their superiority over worked materials, and for having given reasons for that superiority. It was to be hoped that he would repeat those statements over and over again, and particularly when lecturing to engineering societies, as he lectured frequently, because recently foundrymen had been somewhat hard hit by the fact that engineers were asking for wrought materials instead of for cast materials. At the same time, perhaps the foundrymen themselves were partly to blame for that state of affairs, because the engineer had not been able to get castings as satisfactory as they desired in these heat-resisting alloys. It was the foundrymen's duty, therefore, to pay attention to the production of these alloys in the foundry and to satisfy the engineer's requirements. Professor Hanson had pointed out that most of these heat-resisting alloys melted at high temperatures; therefore, the foundrymen would have to improve their melting technique, and also their moulding and casting technique, in order that they might handle the alloys at very high temperatures.

Though Professor Hanson had discussed the effects of various alloying materials upon common metals, perhaps he had not stressed sufficiently the importance of small additions of elements to produce resistance to high temperatures. For example, there were the molybdenum steels, and perhaps it was due to an oversight that he had not referred more particularly to the effects of molybdenum. The nickel-chromium steels had a somewhat better strength at high temperatures than had the ordinary steel, but, surprisingly, the addition of only about 0.5 per cent. of molybdenum increased the strength at high temperatures very considerably indeed. One must always be on the look-out for effects of that nature.

Perhaps the problem of resistance to oxidation did not concern the foundrymen intimately, but it was important not to overlook the fact that these materials might fail as the result of oxidation as well as through low strength at high temperatures. In spite of the figures obtained by Dr. Hatfield, Mr. Dews said he was not sure that he agreed with Professor Hanson that nickel conferred upon steels an increased resistance to high-temperature oxidation. He believed that the tests from which the figures had resulted had covered a period of only 24 hours, and probably that was not a sufficient period to show that nickel did not confer quite the immunity from oxidation at high temperatures that Professor Hanson had mentioned.

The problem of testing materials at high temperatures was one of great difficulty, because the tests occupied such a long time. Professor Hanson had not explained what a creep test was, probably because there had been so much publicity with regard to them, but it was, perhaps, well to point out that these creep tests sometimes occupied months, and even years. It would be a good thing if metal metallurgists of such eminence as Professor Hanson would emphasise this particular disadvantage, and would try to encourage research workers to devote a little of their time to an endeavour to discover tests which could be applied in a practical way to give one an idea of the strength of materials at high temperatures in as short a time as possible.

Mr. W. B. Lake (hon. treasurer of the Institute, and Past-President of the London Branch), seconding the vote of thanks, said that the chief merit of the lecture was the clearness with which it had been presented; though he was not a scientific man, he had been able to understand every word—and no greater compliment than that could be paid to a scientific lecture.

The vote of thanks was carried with acclamation.

(To be continued.)

Ferro-Silicon Syndicate.

Members of the Ferro-Silicon Syndicate recently held a meeting in Berlin, at which the question of a further prolongation of the cartel after December 31, 1931, was principally discussed. According to the cartel's decisions, the question of the renewal has to be settled by June 30, otherwise, as from January 1, 1932, members will be at liberty to make sales on their own account. At the last meeting no definite result was reached, so that a further meeting—probably again in Berlin—will have to be held. At the last meeting members complained about the steady increase in the undercutting of cartel prices by outside producers, forcing the syndicate to make big concessions. It is generally expected that the syndicate will be renewed, as, in the event of dissolution, competition would be still more acute, with the result of a further fall in prices.

Continental Steel Cartel.

The managing committee of the Continental Steel Cartel met in Paris on May 21 to resume the discussions concerning the renewal of the Cartel. As a result of a previous decision to establish an export programme for each country participating, it has been resolved to accept the figures for 1927 and subsequent years as the basis for calculations. The next negotiations will presumably take place at the quarterly meeting in the middle of June. Having regard to the stage of the negotiations, it is considered that the new regulation of the Cartel cannot be brought into operation on July 1, so that a further provisional prolongation may take place.

XUM

Melting Grey and Malleable Iron in the Indirect-Arc Furnace.*

By J. C. Bennett and J. H. Vogel.

The cold-melt production of grey and malleable white irons in the indirect-arc furnace has been successful elsewhere, and it is proposed to describe this operation as practised by the authors and the characteristics of castings produced by it for pressure work. The furnace used is of 1-ton capacity, of the rocking type made by the Detroit Electrice Furnace Company. The steel shell of the furnace has an outside diameter of 5 ft. 9 in. and an overall length of 5 ft., while the corresponding inside dimensions are 3 ft. 8 in. and 3 ft., respectively. The shell is lined with a 4-in. thickness of a well-known brand of insulating brick on which the refractory lining is laid. This latter consists of a special brand of moulded refractory brick which is 8 in. thick.

Advantages of Electric Furnace.

One of the chief advantages of the electric furnace is its flexibility, or the ease with which the chemical and physical properties of the iron can be changed at will. For example, during one day's run of six heats as many as four different kinds of iron have been poured, namely, ordinary grey iron for small pressure castings, low-carbon grey iron with 2 per cent. nickel for manifolds, high-phosphorus iron for piston rings and, finally, malleable iron for large connecting rods.

A second advantage of the electric furnace lies in the fact that the cheapest kind of raw material can be used. The authors' normal grey-iron charge consists of 60 per cent. cast-iron borings and 40 per cent. scrap and sprue. The necessary ferro-silicon is added to prevent undue hardness, and, as indicated above, for certain classes of complicated thin-walled castings, steel is added to close the grain and 2 per cent. nickel is used to prevent chilled sections.

Properties of Grey Iron Obtained.

The properties of the grey-iron heats can best be indicated by a report covering a number of test-pieces cast from the same ladle of electric-furnace iron. Six A.S.T.M. 1¼-in. arbitration bars were cast and broken for transverse strength. They averaged 4,400 lbs. with 0.14 in. deflection. Coupons taken from these bars were then turned to the standard A.S.T.M. requirements for tensile testing and broken. The average in this case was 14.5 tons per sq. in. An analysis was made from the broken test-pieces, and the report submitted shows the iron to contain: T.C., 3.2; C.C., 0.54; Si, 2.52; Mn, 0.60; Ni, 1.93; S, 0.045, and P, 0.207 per cent. The samples from which these results were obtained were taken from a heat for production castings and are representative of results which are obtained in standard fitting heats. Far greater physical properties can be obtained if desired, but it must be remembered that, due to the fact that primarily all the castings made are for pressure work, tightness is more desirable than excessive strength.

Malleable Iron.

A report covering 25 heats of electric-furnace malleable iron, as given by the Malleable Iron Research Institute, show the following averages:—Tensile strength, 25.6 tons per sq. in.; yield point, 17.1 tons per sq. in., and elongation, 22.1 per cent. in 2 in.

The laboratory reports the average white-iron analysis of these heats as follow:—C, 2.10; Si, 1.10; Mn, 0.29; S, 0.043 and P, 0.14 per cent.

The indirect-arc electric furnace is not noted for its ability to melt iron more cheaply than any other unit. However, because of the possibility of using the cheapest raw material available, the cost of the iron at the spout can be brought down to a figure which compares very favourably with the cost of iron when melted in an air-furnace or a cupola.

The data on costs given below were accumulated over a three-month period, during which time 300 heats were run. Subsequent checking has shown that these figures, although they may vary slightly, are in the main representative. All costs given are per ton of 2,000 lbs. unless so stated of iron poured and are based on a melting loss of 2 per cent.

The greatest cost per ton is chargeable to power. The average kw.-hr. consumption is 610 per ton. This may seem high, inasmuch as 600 kw.-hrs. per ton usually is considered a good average figure. However, it must be remembered that this 610 kw.-hrs. includes all power used for preheating, etc. Normally, the daily average is 580 kw.-hrs. per ton, the first heat of the morning running approximately 610, while the last heat of the day usually drops to 550. Malleable heats average slightly greater kw.-hr. consumption, probably due to the higher pouring temperature (usually 580 in a hot furnace. Normal power input is at the rate of 400 kw.

The second cost in order of importance is refractories, the best average cost to date being 10s. 7d. per ton of iron poured. This figure includes all furnace-operation expense items which are chargeable to refractories, including the insulating lining, the refractory lining, both material and installation labour and all patching labour and material. During the run on which these cost figures were accumulated, Silocel insulating material, one particular brand of refractory bricks and another brand of patching material were used entirely.

Procedure in Patching Furnace.

Normally, the last heat of the week is made on Friday afternoon. As soon as the iron is out, the furnace is turned with the door up, the electrodes removed and the discharge line from a small electric blower (10-in. fan, ¼-h.p. motor) is inserted in one electrode port, the other port being plugged. This blower discharge line has a deflector on the end which forces the air toward the bottom of the furnace. The blower is run continuously until Sunday morning, when the patching is done. Incidentally, this blower is also used to force fresh air into the furnace while the workmen are inside patching. This makes it possible for them to remain in the furnace as long as an hour, whereas 15 min. was about the limit without the air.

Before applying the patch, all burned material is chipped out with a pneumatic hammer, the sides of the remaining walls being undercut as much as possible in order to key-in the patch. The patch then is applied approximately ¾ to 1 in. thick and rammed in place with a pneumatic hammer. No attempt is made to maintain the original furnace dimensions by building up the walls, the reason being that the patching material, having practically no bond, will have very little strength unless thoroughly sintered, and apparently the heat does not penetrate a thick patch sufficiently to accomplish this at the back. Consequently, the thick patch breaks out instead of gradually wearing away as the thin, well-fused patch does. The above applies only to the brand of patching material used in this case. An entirely different procedure must be adopted for other patching materials.

After the patching is completed, the furnace is allowed to air-dry until Monday morning, or, if the patching has been excessive, a slow coke fire is started at once and kept going until Monday. Monday morning, prior to charging, the furnace walls are heated to 1,650 deg. C.

As would be expected, the roof of the furnace fails first, inasmuch as it is subjected to the arc without any protection for a longer time than any other portion of the lining. In order to lessen this tendency, the furnace is now being operated upside down at the start of the heat for approximately half the number of heats. In addition to saving the roof, this method of operation also prevents the accumulation of slag on the bottom. In order to prevent electrode breakage due to this procedure, the furnace is charged, rolled over, and the electrodes inserted with the furnace in the upside-down position.

The refractory situation is, in the authors' opinion, the one that offers the greatest opportunity for further reduction in the indirect-arc-furnace operating expense. Shut-downs due to lining failures are rather rare. If the patching is done carefully and consistently a full week's run usually can be obtained. However, to do this it is necessary to repair any spots that are at all doubtful during the regular patching period.

At times it has been necessary to make minor repairs to the hot lining, and for this purpose very good results have been had with a well-known brand of cupola patch. Applying this material consists of mixing it with water to a soup-like consistency and pouring it into the bad spots in the lining by means of a long-handled ladle. It would be expected that this material would blow out immediately due to the generation of steam, but such is not the case. It hardens in place and stands up very well.

Electrode and Labour Costs.

The third item of expense is chargeable to electrodes, which average 9.7 lbs. per ton. Electrode breakage is practically entirely the result of carelessness in handling the furnace, and has been reduced to a minimum in operation through attention to the condition of port holes and proper manipulation, especially at start of heat. Labour cost averages 5s. 10d. per ton of iron poured. One man spends full time on the furnace; a second assists in charging and pouring. Labour cost is high, but cannot be materially reduced for one furnace. In case a second furnace were installed, this item would remain practically constant, with an attendant reduction in labour cost per ton of approximately 40 per cent.

The total melting cost is 73s. 4d. per long ton of iron poured, exclusive of supervision and rent. The total cost per ton at the spout is £6 3s. 9d.

* Abstracted from a Paper read before the Chicago Convention of the American Foundrymen's Association.

Wages in the Light-Castings Industry.

In view of the keen competition by foreign manufacturers of household baths and similar articles, the National Light Castings Employers' Association are proposing a revision of wages in the industry to permit of lower production costs and thus place them in a position to compete effectively with the foreigners. Reductions of 2s. for labourers, 4s. for time workers and 6s. for piece workers are proposed for Scottish and English workers. The unions, representing about 15,000 members, have agreed to consider the proposals and report to a conference to be held on June 23. There are nine unions concerned, and the centres affected are Falkirk, Glasgow and the West of Scotland.

MESSRS. ASHMORE, BENSON, PEASE & COMPANY, LIMITED, have received from the British (Guest Keen Baldwins) Iron & Steel Company, Limited, Cardiff, an order for a Freyn-design continuous stock-line recorder, comprising winch, control panel, electric recording motor and two-lamp target indicators. The equipment will be installed on the firm's No. 4 blast furnace.

The Production of an Aluminium-Alloy Casting.*

By E. Jackson.

The increasing use of light aluminium castings has made the aluminium foundry a correspondingly important industrial concern. Aluminium alloys easily with most metals, except lead, to give a variety of alloys which are renowned for their lightness and strength. The chief metals used for alloying with aluminium are zinc, magnesium, manganese and copper, also the metalloid silicon.

In the melting of aluminium prior to casting, widely-differing designs of furnaces are used, and equally good results are obtained, whether the furnaces are fired by coke, gas, oil or electricity. The choice should rest with the following considerations:—Aluminium is readily oxidised, and the higher the temperature reached the higher the oxidation losses. Therefore, furnaces for aluminium must have their temperature readily controllable. The melting point of aluminium is about 650 deg. C., and for general purposes it is seldom necessary to exceed 700 deg. C., but, where necessary, this temperature may be exceeded by another 100 deg. C., if no stewing takes place, for oxidation proceeds steadily whilst the metal is molten. The surface of the metal should be undisturbed because the scum of oxide is the best preventive to further oxidation.

Moulding Practice.

In general, the making of the mould for aluminium-alloy castings is the same as for brass, but depending, of course, on the type of work. The sand used is the ordinary foundry sand with a clay bond. When making the moulds it is found best to ram lightly and vent well; this view is taken because of the lightness of the alloys, they are unable to drive the air and gases out of the moulds as quickly as most metals. Therefore the moulds must have easy exit for the gases, so that they offer no resistance to the flow of the metal. Many mis-run castings are due to this lightness of the metal. Where necessary, whistles should be placed at suitable points to allow the air and gases to escape. The cores used for aluminium should be just strong enough to hold together, as cores are responsible for most cracked castings.

When the mould is ready for casting, the crucible is taken from the furnace and the dross removed. The best way is to stir the metal from the bottom upwards, taking care to disturb the surface as little as possible, and then remove the dross just before casting.

Pouring.

In some foundries where they do not possess a pyrometer, a little difficulty is experienced in gauging the correct temperature for casting. A rough method is to place a wrought-iron rod into the metal and to cast when the metal starts to adhere to the rod. It is a very rough method, but with practice proves very satisfactory.† It is very important that the temperatures when casting aluminium alloys should not be high, because the liquid shrinkage averages 1 per cent. for each 100 deg. C. Therefore, a casting poured at 1,000 deg. C. would have a shrinkage of 3 per cent. before it reached its melting-point, 700 deg. C., which is the average temperature for pouring. This shrinkage is distinct from the solid contraction which takes place in the casting after solidification. The strongest and soundest castings in aluminium are those which solidify rapidly. If the process of solidification is slow, gases are allowed to come out of solution, causing unsound porous castings. Bearing in mind that the metal has to reach the mould on the point of solidification, large gates have to be used so that the mould is rapidly filled, or there will be mis-run castings owing to the rapidity at which the metal cools.

One feature of aluminium-alloy castings is that they should not be left in the mould too long after casting, or a dirty colour is obtained instead of a nice white casting, due to oxidation. The runners and risers do not knock off as in the case of iron; they are best dressed off these by means of a band saw with fine teeth followed by finishing on a grinding wheel. The dressing and finishing is exceptionally easy. The foregoing points on producing aluminium-alloy castings can only be stated to be general principles. The design of the casting, the method of production and the purpose for which the castings are to be used will modify these principles accordingly.

* A Paper read before the Lancashire Junior Section of the Institute of British Foundrymen, which was awarded first prize in a Short-Paper Competition.

† The diameter of the rod should be standardised.—Editor.

A Large Single-Faced Sluice.

By Our Engineering Correspondent.

The enormous developments throughout the world in the development of electricity by means of water power, and over 40,000,000 h.p. is now installed, have resulted in the production of many fine examples of heavy castings. In this connection, of interest is the new Pykara Hydro-electric scheme in Southern India, the first section of which is in course of construction, having been sanctioned in September, 1929, with the main directing centre at the Pykara Construction Workshop, 12 miles from Ootocamund. The Pykara River drains the high Nilgiris Plateau in the Madras Presidency, rising on the slopes of the Mukurti Peak, and after a long winding course of about 15 miles on the plateau plunges down to the plains, 4,000 ft. below, in two falls of 180 and 200 ft. and a series of cataracts, within a distance of only a few miles. In the plains the river is then known as the Moyar, which flows into the Bhavani River.

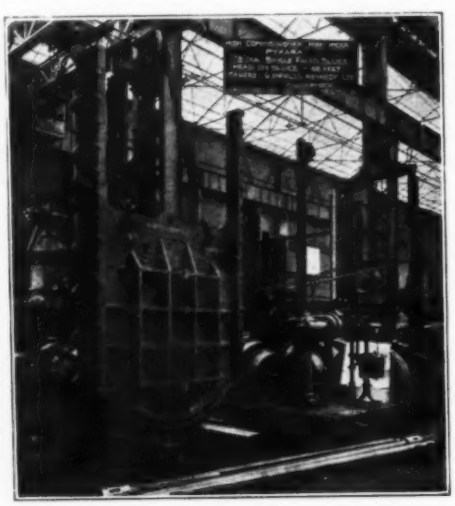


Fig. 1.—The 78-in. dia. Single-Faced Sluice supplied by Glenfield & Kennedy, Limited, for the Pykara Hydro-Electric Scheme.

The Pykara scheme is to utilise the first 3,000-ft. drop for the generation of electricity, and eventually, probably in about 10 years, another scheme, the Moyar, will be developed to make use of the remaining 1,000 ft. Altogether the Pykara River represents about 100,000 h.p., but the first section will develop 21,000 h.p. by means of current to the Nilgiris and Coimbatore districts, although in the future the South India Railway and the City of Madras, 360 miles away, are to come into the area. The present section will cost about 126.4 lakhs of rupees (£625,000), and is to be completed by 1932, representing three years' work.

There has been supplied for Pykara by Glenfield & Kennedy, Limited, of Kilmarnock, a 78-in. dia. single-faced sluice to the order of the High Commissioner for India. This is constructed throughout of cast iron, with gunmetal faces securely recessed in position, pinned and hand-scraped to form a watertight bearing, operating under a head of 46 ft., while the control is by means of an electrically-operated headstock. The power of the motor is transmitted through spur and worm reduction gear to lifting rods bolted to the door, and there is embodied the firm's standard taper wedge guides at the back of the door, which force it on to its face in the closed position. Also the installation is designed for withstanding pressure from one side only, and in general the operating gear is of standard type with rising spindle and limit switches which cut off the current at the extremes of the valve travel, bolted to the indicator hood.

Much other material is being supplied by Glenfield & Kennedy, Limited, to the Pykara scheme, which will operate at about 3,000-ft. head as stated, including a number of cast-steel valves, of various sizes, with their attendant auxiliary equipment.

The principal users of the power from the first section will be the cotton mills of Coimbatore, Tiropur and Pollachi, probably to the extent of about 10,000 h.p. Also a considerable proportion of the load is required for the tea estates in the Nilgiris and Anamlais areas, and other fields are general lighting, as well as flour mills, rice mills, ginning mills and similar establishments, while it is hoped also to develop an extensive demand from agriculture, especially in connection with pumping for irrigation.

Notes from I.B.F. Branches.

Falkirk Section.—On the invitation of Colonel Allan Stein, M.C., members of the Falkirk Section of the Institute of British Foundrymen visited the Castlecary brickworks of Messrs. J. G. Stein & Company, Limited, on May 27. The party was first conducted through the new research department, where demonstrations of various types of apparatus were given. The various tests applied for the control of the quality of the materials were also explained. The party then proceeded to visit the various departments of the works where the processes for the production of various types of bricks and refractories were examined under working conditions.

Lancashire Junior Section.—On May 16 about 60 members of the Lancashire Junior Section of the Institute of British Foundrymen paid a visit to the Clay Cross Iron Works, near Chesterfield. The party travelled by motor coach from Manchester and were welcomed at Clay Cross by Major Jackson, Mr. D. Rushworth and other members of the staff. They then commenced to inspect the works, starting at the pipe foundry, the economiser plant and machine shops. Much interest was displayed in an original engine constructed by George Stephenson when he and the original Mr. Jackson were partners, and in the conduct of the coke ovens, including the preparation of the burden, the method of transferring it into the oven and the discharging of the contents when coked. After inspecting the blast furnace, the party journeyed to Ashover by the light railway, laid down by the Clay Cross Company to transport limestone from the quarries. After luncheon, a hearty welcome was given to the visitors by Major Jackson and Mr. Rushworth. Mr. Grundy thanked the Clay Cross Company for their kindness, and reviewed, for the benefit of the Junior Section, the past history of the company. Mr. R. Yeoman and Mr. Burgess supported the vote of thanks.

During the afternoon the limestone and fluor-spar quarries and mines were inspected. After tea the party departed for home.

Trade Talk.

MESSRS. MARSHALL, SONS & COMPANY, LIMITED, Gainsborough, have received a substantial order for machinery for Russia.

"BRITISH ENERGY," a new tanker built by the Greenock Dockyard Company, Limited, has completed successful trials on the Clyde.

MESSRS. JOHN BAIRD inform us that their head office is now at 147, Blythswood Street, instead of 68, Bath Street, Glasgow. The telephone number is unchanged.

THE PULSOMETER ENGINEERING COMPANY, LIMITED, removed their London office on June 1 from 11, Tothill Street to 39, Victoria Street, Westminster, London, S.W.1.

SIR JOHN M. MACLEOD has intimated to the joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board that, as a result of his examination of the employers' books for March and April, the average net selling price was £10 7s. 2.41d. As a result, the basis rates in the workers' wages will be reduced by 2½ per cent.

AN OUTBREAK OF FIRE which occurred in the Chattan Foundry of Messrs. Mitchell, Russell & Company, Limited, Bonnybridge, and which originated in the Berlin blacking department, was subdued by the fire brigade attached to the neighbouring foundry of Messrs. Smith & Wellstood, Limited. Damage was confined to a comparatively small area.

MESSRS. JAMES CURRIE & COMPANY, LIMITED, shipowners, Leith, have placed orders for two new cargo and passenger steamers for their Leith-Hamburg service. One vessel is to be built by Messrs. Henry Robb, Limited, Leith, and the other by Messrs. Barclay, Curle & Company, Limited, Glasgow. The vessels will be sister ships, each 250 ft. in length, with a deadweight tonnage of about 1,550.

THE GOODWILL AND PATENT RIGHTS of Rotary Louvre Furnaces (System Pehrson), Limited, have been purchased by Messrs. Dunford & Elliott (Sheffield), Limited, who have created a special department, with headquarters at 54, Victoria Street, London, S.W.1, under the management of Mr. W. R. Chapman, to carry on the business in dryers, roasters and coolers previously carried on by Rotary Louvre Furnaces (System Pehrson), Limited.

THE BRITISH ALUMINIUM COMPANY, LIMITED, has started the second stage of the Lochaber Power Scheme, entailing the construction of an aqueduct between Loch Laggan and Loch Treig and a dam at the end of the latter to permit of the loch being raised by a height of about 36 ft. The raising of this water level will necessitate a diversion of 1½ miles of the L.N.E.R. West Highland line at the north end of the loch, and this work is now in hand.

THE DIRECTORS of six important Lancashire textile machinery companies have decided to submit to shareholders and recommend for their acceptance a scheme of amalgamation. The companies concerned are Messrs. Asa Lees & Company, Limited; Brooks & Doxey (1920), Limited; Dobson & Barlow, Limited; Howard & Bullough, Limited; John Hetherington & Sons, Limited, and Platt Bros. & Company, Limited. The total issued share capital amounts to nearly £7,350,000.

THE MINISTRY OF INDUSTRIES in China is reported to have drafted a plan for the establishment of a large steelworks at Pukow, to be operated as a State enterprise. A memorandum on the subject is said to have been submitted by the Ministry to the Nanking Government for consideration. The production of iron and steel in large quantities at a low price is considered to be essential in China's industrial development; the annual import of iron and steel into China amounts to between 500,000 and 600,000 tons. Large quantities of constructional material will be required in all parts of the country, especially in connection with the building of railways and in the reconstruction of the capital city of Nanking. In regard to the available supply of iron ore, experts attached to the Ministry of Industries estimate that in the lower part of the Yangtsze valley there are large deposits.

MESSRS. VICKERS, LIMITED, recently entertained a number of visitors to luncheon at the St. Ermin's Hotel, Broadway, Westminster, London, S.W., to mark the opening of a new showroom at Vickers' House. This showroom has been opened in order that customers, especially those from abroad, may be able to inspect examples of the many branches of Vickers' manufacture without having to leave London. The exhibits consist principally of two classes, those of a national significance, viz., armaments, etc., and those for everyday industrial use, such as passenger ships, non-military aircraft, coal-hoisting machinery, etc. Mr. D. Vickers, who presided, in the course of a few remarks, referred to the firm's activities during the war, and the great developments which have taken place since. The showroom is situated at Vickers House, Broadway, Westminster.

A FEATURE IN THE freight markets latterly was the chartering by Russia of tonnage to load British pig-iron from Cardiff to Leningrad, while business was also concluded for pig-iron from Rotterdam, and further inquiries were in circulation. Actual fixing included two Danish steamers of 5,000 tons each from Cardiff to Leningrad at the low rate of 5s. f.i.o. for prompt loading, and a vessel of 10,000 tons from Rotterdam to Novorossisk at 6s. 3d. f.i.o., also for prompt shipment, this boat being simultaneously fixed with manganese ore from Poti to United States Northern ports at $3.25 for June loading. It is interesting to note that the rate originally quoted for the Rotterdam to Novorossisk voyage was only 5s., but shippers were eventually forced to pay the extra 1s. 3d. per ton. Another vessel of 5,000 tons is now wanted for pig-iron from Cardiff to Leningrad at 5s. f.i.o. for early June loading, while tonnage is also needed for about 30,000 tons of hematite from Wales to Russia.

GOVERNMENT CONTRACTS recently placed include the following:—Admiralty—Steel blooms: Wm. Beardmore & Company, Limited, Glasgow; Colvilles, Limited, Glasgow; Lanarkshire Steel Company, Limited, Motherwell. Steel bolts and nuts: C. Richards & Son, Limited, Darlaston; E. Merecr, Limited, Hollinwood; the Rivet Bolt & Nut Company, Limited, Glasgow; Stones Bros, Limited, West Bromwich. Bar iron: Lancashire Steel Corporation, Limited, Irlam; Thomas Walmsley & Sons, Bolton. Steel sheets, "D": Colvilles, Limited, Glasgow. Steel sheets, N.T.T.: British (Guest Keen Baldwins) Iron & Steel Company, Limited, Cardiff; Dorman, Long & Company, Limited, Middlesbrough; John Lysaght, Limited, Newport, Mon.; South Durham Steel & Iron Company, Limited, West Hartlepool. Steel sheets, tensile tested: British (Guest Keen Baldwins) Iron & Steel Company, Limited, Cardiff; Consett Iron Company, Limited, Consett; Smith & McLean, Limited, Glasgow; South Durham Steel & Iron Company, Limited, West Hartlepool; Steel Company of Scotland, Limited, Glasgow. War Office:—Pig-iron: Barrow Hematite Steel Company, Limited, Barrow-in-Furness. Steel billets: Darlington Forge, Limited, Darlington; Langley Forge Company, Limited, Birmingham. Crown Agents for the Colonies:—Pipes: Stanton Ironworks Company, Limited, Nottingham. Steel poles: British Mannesmann Tube Company, Limited.

Reports and Dividends.

Park Gate Iron & Steel Company, Limited.—Profit, £33,210; brought in, £4,235; depreciation, £25,000; carried forward, £12,445.

Anderston Foundry Company, Limited.—Net loss, £1,723; brought in, £2,670; from reserve, £2,500; from workmen's compensation fund, £3,500; dividend of 4 per cent.; carried forward, £2,297.

Amalgamated Metal Corporation, Limited.—Net profit, £298,318; preference dividends, £53,917; dividend on the ordinary shares of 5 per cent.; written off preliminary expenses, £18,751; carried forward, £11,360.

Glenfield & Kennedy, Limited.—Profit, £53,139; brought in, £65,028; to staff pension fund, £7,000; to reserve, £10,000; final dividend of 6 per cent. on the ordinary shares, making 10 per cent.; carried forward, £65,581.

Allied Ironfounders, Limited.—The directors recommend payment of the dividend on the 7 per cent. cumulative preference shares for the year to March 31, 1931, but do not recommend any dividend on the ordinary shares.

Erratum.—On page 372 of our last issue we published a photograph of "The Runner," a life-sized figure cast in B.C.L.-refined aluminium alloy. This was the work, not (as was stated) of Mr. E. Longden, of Manchester, but of his brother, Mr. John Longden, foundry manager, of Messrs. J. & D. Tullis & Company, Limited, Clydebank, Glasgow.

Personal.

MR. J. E. JAMES, formerly director and general manager of the Cargo Fleet Iron Company, Limited, who has taken up the position of managing director of the Lancashire Steel Corporation, Limited, was the recipient of several presentations when he left Tees-side.

A REMARKABLE RECORD of service is held by Mr. Walter Bugg, of Scotstoun, Glasgow. Mr. Bugg, an engineer, has been in the employment of Messrs. Yarrow & Company, Limited, for over 50 years, and, after completing his apprenticeship in the Great Eastern locomotive works at Stratford, commenced service with Messrs. Yarrow at Poplar in 1881. In 1885 he was engaged in Egypt in the construction of river steamers for the Nile Expedition. Since then he has been in many parts of the world as Messrs. Yarrow's representative. He is still in the firm's service, and his 50 years is the longest service rendered by an engineer of the firm.

MR. W. R. BARCLAY, for some years managing director of Messrs. Henry Wiggin & Company, Limited, has been appointed consulting metallurgist to the Mond Nickel Company, Limited, with headquarters in London. Mr. A. P. Hague, general manager of the company's Clydach refinery, will succeed Mr. Barclay as general manager and continue as general manager at Clydach. Mr. E. W. Asbury, who has for many years managed the sales department of Henry Wiggin & Company, Limited, with headquarters at Birmingham, will, at the beginning of June, move to the offices of the Mond Nickel Company, Limited, at Imperial Chemical House, Millbank, London, where he will continue in charge of the sales business of Henry Wiggin & Company. These changes, with the appointment of the Mond Nickel Company as sole director and manager of Henry Wiggin & Company, in place of the present board, and the transfer of the registered office to London, are being carried out with a view to effecting closer collaboration between the various interests of the Mond Nickel Company. Mr. D. Owen Evans, delegate director of the Mond Nickel Company, will assume the same position with regard to Henry Wiggin & Company.

Will.

WOODWARD, ROBERT, chairman of Messrs. Edgar Allen & Company, Sheffield, steel manufacturers and engineers ... £27,628

Obituary.

MR. RICHARD GILLOTT MARPLE, a director of Messrs. Marple & Gillott, Limited, scrap merchants, Attercliffe, Sheffield, died recently.

MR. R. B. ARMSTRONG, managing director of Messrs. R. & W. Hawthorn, Leslie & Company, Limited, St. Peter's Works, Hebburn-on-Tyne, died on Sunday, May 24. Mr. Armstrong was appointed in March to the board as a successor to the late Sir Archibald Ross. For many years he was general manager of the St. Peter's Works.

New Companies.

Leeds Metallics, Limited, 13, Bowman Lane, Leeds.—Capital £1,000. Directors: A. W. Calvert and W. H. Swan.

H. Johnson Foster, Limited, Courts 1 and 3, Trent Street, Sheffield.—Capital £2,000. Iron and steel merchants, etc. Director: H. J. Foster.

J. R. Patton & Company, Limited, Windermere Works, Windermere Road, West Hartlepool.—Capital £1,000. Scrap-metal merchants, etc. Directors: T. Thomas, F. P. Spence and H. Wilde.

Contracts Open.

Barlow, Cambiesforth, etc.—Cast-iron, steel and galvanised water mains, etc., for the Selby Rural District Council. The Clerk, 1, Abbey Place, Selby. (Fee £2, returnable.)

Birkenhead, June 10.—Iron and steel stores, for the Gas Department. The Gas Engineer, Gasworks, Thomas Street, Birkenhead.

London, S.W., June 26.—20 four-wheeled covered wagons and two four-wheeled oil-tank wagons, for the Mysore Railways. Messrs. Rendel, Palmer & Tritton, consulting engineers, 55, Broadway, Westminster, S.W.1. (Fee 15s., non-returnable.)

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The pig-iron market in this area is in an unsatisfactory position. A very limited number of transactions has taken place, and they have practically all been for very small quantities. Cleveland pig-iron is not at a competitive price in other areas, and the industrial depression has restricted the needs of local consumers. The difficulty of disposing of the surplus iron available for the open market does not tend to decrease. So far as can be ascertained, no additional orders appear to have been secured as a result of the recent offers of increased concessions to Scottish consumers of Cleveland iron, and deliveries to that area certainly show no increase. Some improvement may be noted when deliveries from abroad under running contracts are completed, but imported iron is still substantially cheaper than Cleveland iron delivered into Scotland. Export orders are scarce and are mainly for distant destinations, while trade with local consumers is on a hand-to-mouth basis. Prices, however, are still unaltered, the fixed minima to all destinations except Scotland being:—No. 1 Cleveland foundry iron, 61s.; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton, f.o.b. or f.o.t.

Little change can be recorded this week in the hematite market. The two additional hematite furnaces started at Middlesbrough are now in full blast, and regular deliveries have commenced against contracts which were negotiated before the works were put into operation. These are sufficient to absorb nearly the whole of the output for two or three months. There is still, however, pressing need to reduce stocks. Producers are not hesitating to sell at a sacrifice, and prices have become very irregular. Nominally, East Coast mixed numbers are unchanged at 65s., and No. 1 quality at 65s. 6d. per ton. These figures are really only obtainable for small prompt parcels. For larger quantities lower prices are accepted, but such orders are scarce, consumers being inclined to hold off in the expectation of still lower prices. Bessemer mixed numbers on the North-West coast are 2s. per ton lower at 66s. at works.

LANCASHIRE.—The demand for foundry iron in this area is very small, and only a limited amount of business has been done. For delivery to consumers in the Manchester zone, Derbyshire and Staffordshire descriptions are quoted at 67s. per ton, with North-East Coast iron also at 67s. The price of Northamptonshire foundry is 65s. 6d. and Derbyshire forge 62s. Scottish foundry brands are at about 88s., with West Coast hematite iron at 80s. 6d.

MIDLANDS.—The lower prices have stimulated business, and although the consumers are mainly taking small quantities for their immediate requirements, the tone of the market is much improved. For delivery to Birmingham and Black Country stations the furnaces still quote 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—Business in Scotland is very slack. The demand is poor, and there is a complete absence of forward contracting. The Scottish pig-iron makers are adhering to their current fixed minimum price of 73s. 6d. per ton for No. 3 foundry, f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1. The price of Continental No. 3 is 52s., f.o.t. Grangemouth, and Middlesbrough No. 3 is at 59s. 6d.

Finished Iron.

Little business is being done in this market. The position is, if anything, worse than it was last week. The makers of marked bars are only moderately occupied, but maintain their figure of £12 at works. The mills dealing with crown and cheaper grades of iron find the position unsatisfactory, as they are quite unable to obtain anything like sufficient tonnage to work their mills regularly. Crown bars are offered, in South Staffordshire, at prices between £9 5s. and £10, and nut and bolt iron at £8 12s. 6d. to £8 15s. Belgian No. 3 iron is offered quite freely at between £4 15s. and £4 17s. 6d. delivered.

Steel.

The steel trade is experiencing a shortage of orders for almost all grades of material. The continued depression in the shipbuilding and heavy engineering industries is severely affecting operations at the finished-steel works. Orders for plates, sections and joists are urgently needed in all districts. The works are completing orders more rapidly than new business materialises and there is real anxiety at the position. The market for small steel bars is weak. The demand for semi-finished steel has dwindled to small proportions. Continental prices are still weak, and prices quoted by the British works also are none too firm. No immediate improvement in this market seems likely. The lower prices now quoted for galvanised sheets have produced a few more orders, but, generally, this section of the steel industry is very depressed.

Scrap.

In the Cleveland area very little business is being done in the iron and steel scrap market. The consuming works are sharing in the general depression, and their needs are small and easily satisfied. Heavy steel scrap is quoted at 40s. per ton, with ordinary-quality cast-iron scrap at 45s., and good machinery quality at 46s. 6d. In South Wales the position is also most unsatisfactory. Supplies are plentiful, but there is no demand, and, consequently, prices are nominal. The Scottish market is also in a very depressing condition. Prices of all classes of scrap are easy. First-class machinery metal, in pieces not exceeding 1 cwt., is quoted at 50s., while ordinary cast-iron scrap to the same specification is at 46s. to 47s. 6d. The above prices are all delivered consumers' works.

Metals.

Copper.—The copper market is still in a very unsatisfactory position. At its present price there is little demand for the metal. If the price were still lower it is possible that there might be an improvement in the position, but there would still remain the depression in the consuming industries, which is, of course, the root of all the evil. In America it is reported that the industrial position is even worse than before. It had been anticipated that a great revival of prosperity was due, but this optimism was unfounded. The consuming industries are still in great need of more business.

Closing quotations:—

Cash.—Thursday, £36 16s. 3d. to £36 17s. 6d.; Friday, £36 2s. 6d. to £36 3s. 9d.; Monday, £35 16s. 3d. to £35 17s. 6d.; Tuesday, £35 1s. 3d. to £35 2s. 6d.; Wednesday, £34 7s. 6d. to £34 10s.

Three Months. — Thursday, £37 10s. to £37 11s. 3d.; Friday, £36 16s. 3d. to £36 17s. 6d.; Monday, £36 10s. to £36 11s. 3d.; Tuesday, £35 15s. to £35 17s. 6d.; Wednesday, £35 1s. 3d. to £35 3s. 9d.

Tin.—The outlook in the tin market is still depressing. Consumption shows no improvement, and, until stocks are much reduced, it is impossible to say how much further prices will drop. The various rumours regarding further restriction of output seem to have an unfortunate effect on the market.

Official closing prices:—

Cash.—Thursday, £101 7s. 6d. to £101 10s.; Friday, £100 12s. 6d. to £100 15s.; Monday, £100 12s. 6d. to £100 15s.; Tuesday, £100 12s. 6d. to £100 15s.; Wednesday, £100 7s. 6d. to £100 10s.

Three Months.—Thursday, £102 17s. 6d. to £103; Friday, £102 2s. 6d. to £102 5s.; Monday, £102 2s. 6d. to £102 5s.; Tuesday, £102 to £102 5s.; Wednesday, £102 to £102 2s. 6d.

Spelter.—The consuming trades are themselves receiving very little business, and therefore few orders are being placed. However, the low price should ultimately have the effect of improving the demand.

Daily fluctuations:—

Ordinary.—Thursday, £10 6s. 3d.; Friday, £10; Monday, £9 18s. 9d.; Tuesday, £9 16s. 3d.; Wednesday, £9 13s. 9d.

Lead.—The industrial situation does not hold out the prospect of an immediate improvement in the position of this market. So far as the cable trade is concerned there has been rather more buying in this country, but otherwise consumption is at a low level.

The week's prices have been:—

Soft Foreign (Prompt).—Thursday, £11; Friday, £10 12s. 6d.; Monday, £10 16s. 3d.; Tuesday, £10 13s. 9d.; Wednesday, £10 7s. 6d.

Birmingham Convention Fund.

Second List.

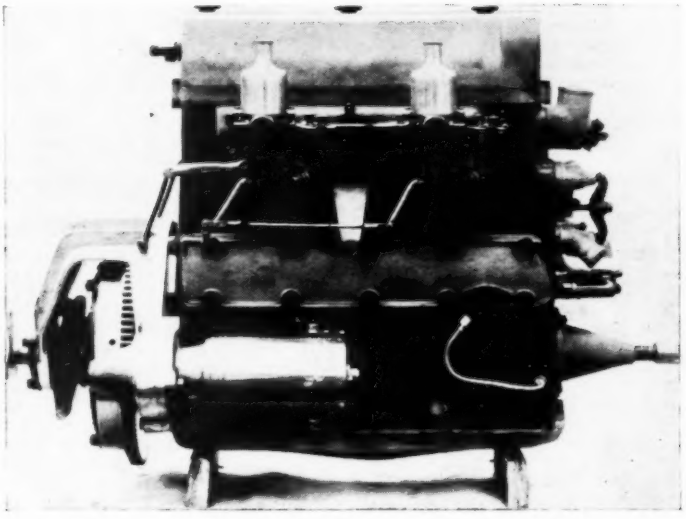
We have received from Mr. F. K. Neath, the hon. convention secretary, a further list of subscriptions, which are set out in the following list.

	£	s.	d.
Amount previously Acknowledged	278	10	0
Per Foundry Trades Equipment & Supply Association:—			
Foundry Plant and Machinery Company, Limited	3	3	0
Paterson, Hughes Engineering Company, Limited	1	1	0
Tredegar Associated Collieries & Shipping Company, Limited ...	5	5	0
S. W. B. Stephen & Company, Limited	5	5	0
John Wright & Company	5	0	0
British Pigirons, Limited	3	3	0
Wm. Olsen Limited	2	2	0
Farringdon Works and H. Pontifex & Sons, Limited	2	2	0
Mr. F. E. McGrah	2	2	0
Mineral & Refractory Products Limited	2	2	0
John G. Stein & Company, Limited	2	2	0
Mr. S. Smith		10	0
Total	£312	7	0

CAST IRON FLANGED PIPES
2 in.–12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

F.J.T. 4.6.31.

No need to fetter the car.



By courtesy of Aston Martin, Ltd.

Surplus weight is as fetters to a car, detrimentally affecting running costs and performance. Light alloys of aluminium unfetter both engine and chassis.

To the good casting properties of aluminium alloys must be added easy machining which simplifies the completion of even the most intricate castings.

In the Aston Martin engine illustrated, light alloys of aluminium are employed for rocker cover and plate, clutch bracket, control bracket, filter cover, sump, pipes, starting handle bracket and front cover.

WRITE FOR THIS BOOKLET.

Light of Aluminium

THE BRITISH ALUMINIUM CO. LTD.

ALUMINIUM PRODUCERS, ADELAIDE HOUSE, LONDON, E.C.4

'Phone: Mansion House, 5561 & 8074 (5 lines).
Telegrams: Cryolite, Bilgate, London.

Special CARBON BLACKING

PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST
REQUISITES

67 YEARS EXPERIENCE. MADE BY A FIRM WITH

Also—
GANISTER,
LOAM AND SAND MILLS.
STUDS,
CHAPLETS,
BRUSHES,
CORE ROPES,
BUCKETS,
SPADES, Etc.
LADLES,
FIRE BRICKS,
STONE FLUX,
CASTING CLEANERS,
PIPE NAILS,
SPRIGS,
WIRE BRUSHES,
BELLOWS.

JAS. DURRANS & SONS. LIMITED.
PHŒNIX WORKS
PENISTONE . NR SHEFFIELD.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	34	7	6
Three months	35	1	3
Electrolytic	39	0	0
Tough	36	0	0
Best selected	36	5	0
Sheets	70	0	0
India	48	10	0
Wire bars	40	10	0
Do., July	40	10	0
Do., August	40	10	0
Ingot bars	40	10	0
H.C. wire rods	42	0	0
Off. av. cash, May	38	18	10¼
Do., 3 mths., May	39	11	10⅞
Do., Sttlmnt., May	38	18	10½
Do., Electro, May	42	13	1½
Do., B.S., May	40	16	4⅝
Do., wire bars, May	43	2	9
Solid drawn tubes			10½d.
Brazed tubes			10½d.
Wire			6¼d.

BRASS.

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	8d.
Wire	7½d.
Rolled metal	7½d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN.

	£	s.	d.
Standard cash	100	7	6
Three months	102	0	0
English	101	10	0
Bars	103	15	0
Straits	102	7	6
Australian	101	17	6
Eastern	102	10	0
Banca	103	12	6
Off. av. cash, May	104	8	0
Do., 3 mths., May	105	14	10½
Do., Sttlmt., May	104	8	0

SPELTER.

	£	s.	d.
Ordinary	9	13	9
Remelted	9	5	0
Hard	7	0	0
Electro 99.9	12	0	0
English	10	5	0
India	9	15	0
Zinc dust	18	0	0
Zinc ashes	2	0	0
Off. aver., May	10	13	7⅛
Aver. spot, May	10	9	8¼

LEAD.

	£	s.	d.
Soft foreign ppt.	10	7	6
English	12	0	0
Off. average, May	11	12	8¼
Average spot, May	11	9	9¾

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	20	0	0
Do., V.M. ex-whf.	19	0	0
Rods	20	10	0
Boiler plates	13	0	0
Battery plates	14	10	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	36	0	0
Chinese	23	0	0
Crude	22	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	17	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	10	0
45/50%	10	10	0
75%	15	0	0
Ferro-vanadium—			
35/50%	12/8 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	4/2 lb. Mo.		
Ferro-titanium—			
23/25% carbon-free	9½d. lb.		
Ferro-phosphorus, 20/25%	£15	10	0
Ferro-tungsten—			
80/85%	1/8½ lb.		
Tungsten metal powder—			
98/99%	1/11½ lb.		
Ferro-chrome—			
2/4% car.	£29	0	0
4/6% car.	£21	5	0
6/8% car.	£20	12	6
8/10% car.	£20	0	0
Ferro-chrome—			
Max. 2% car.	£29	15	0
Max. 1% car.	£34	2	6
Max. 0.70% car.	£36	0	0
70%, carbon-free	9½d. lb.		
Nickel—99%	£170 0 0 to £175	0	0
Ferro-cobalt	9/- lb.		
Aluminium 98/99%	£85	0	0
Metallic chromium—			
96/98%	2/7 lb.		
Ferro-manganese (net)—			
76/80% loose	£10 15 0 to £11	5	0
76/80% packed	£11 15 0 to £12	5	0
76/80% export	(nom.) £ 9	0	0
Metallic manganese—			
94/96% carbonless	1/3 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales						
Heavy steel	2	2	6 to	2	5	0
Bundled steel and shrngs.	1	15	0 to	2	0	0
Mixed iron and steel	1	17	6 to	1	19	0
Heavy cast iron	2	5	0 to	2	6	0
Good machinery for foundries				2	10	0
Cleveland—						
Heavy steel				2	0	0
Steel turnings				1	7	6
Cast-iron borings				1	4	0
Heavy forge				2	14	0
W.I. piling scrap				2	10	0
Cast-iron scrap	2	5	0 to	2	6	6
Midlands—						
Light cast-iron scrap				1	17	6
Heavy wrought				2	12	6
Steel turnings					—	
Scotland—						
Heavy steel	1	17	6 to	2	0	0
Ordinary cast iron				2	2	6
Engineers' turnings				1	8	0
Cast-iron borings				1	11	0
Wrought-iron piling				2	10	0
Heavy machinery				2	9	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	28	0	0
Brass	20	0	0
Lead (less usual draft)	8	10	0
Tea lead	5	10	0
Zinc	4	0	0
New aluminium cuttings	46	0	0
Braziery copper	25	0	0
Gunmetal	29	0	0
Hollow pewter	68	0	0
Shaped black pewter	43	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	65/6
Hematite M/Nos.	65/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	73/6
„ d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands—	
Staffs common*	—
„ No. 4 forge*	61/-
„ No. 3 fdry.*	66/-
Shrops basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	57/6
„ fdry. No. 3*	62/6
„ fdry. No. 1*	65/6
Derbyshire forge*	61/-
„ fdry. No. 3*	66/-
„ fdry. No. 1*	69/-
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	76/-
„ No. 3	73/6
Hem. M/Nos. d/d	72/-
Sheffield (d/d district)—	
Derby forge	58/6
„ fdry. No. 3	63/6
Lincs forge	—
„ fdry. No. 3	63/6
E.C. hematite	80/-
W.C. hematite	82/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
„ fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	88/-
Eglinton, No. 3	88/-
Gartsherrie, No. 3	88/-
Monkland, No. 3	88/-
Shotts, No. 3	88/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)	9	15	0 to	10	10	0
Nut and bolt iron	8	12	6 to	8	15	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				14	5	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	17	6 to	9	12	6
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)	7	2	6 to	7	10	0
Flats—8 in. wide and over				8	12	6
„ under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)				9	5	0
Black sheets, 24g.	8	10	0 to	9	10	0
Galv. cor. shts. 24g.	10	5	0 to	10	10	0
Galv. flat sheets	10	15	0 to	11	0	0
Galv. fencing wire, 8g. plain				12	0	0
Billets, soft	5	0	0 to	5	7	6
Billets, hard	6	12	6 & up.			
Sheet bars	5	0	0 to	5	5	0
Tin bars	4	15	0 to	5	0	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11½d.
Sheet to 10 w.g.	11⅝d.
Wire	1/0½
Rods	11⅝d.
Tubes	1/6¾
Castings	11½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/- to 10 g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.26
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	12.00
Basic	18.26
Bessemer	18.76
Malleable	18.76
Grey forge	18.26
Ferro-mang. 80%	80.00
O.-h. rails, h'y, at mill	43.00
Billets	29.00
Sheet bars	29.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.65
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.65
Skelp, sheared steel	1.65
Steel hoops	1.85
Sheets, black, No. 24	2.15
Sheets, galv., No. 24	2.80
Sheets, blue an'l'd, No. 13	2.00
Wire nails	1.80
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	22/6 to 25/-
„ furnace	15/- to 16-
Durham and Northumberland—	
„ foundry	13/-
„ furnace	13/- to 13/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	14/3	to 14/6
„	28×20 „	28/6	to 29/-
„	20×10 „	—	
„	18¾×14 „	—	
C.W.	20×14 „	13/6	
„	28×20 „	—	
„	20×10 „	—	
„	18¾×14 „	—	
Terneplates	28×20	31/- per box basis f.o.b.	

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.	£	s.	d.
Pig-iron	£8	0	0 to	£7	10	0
Bars, hammered, basis	£17	10	0 to	£18	10	0
Bars and nail-rods, rolled, basis	£15	17	6 to	£16	15	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£32	0	0 to	£33	0	0
Faggot steel	£20	0	0 to	£24	0	0
Bars and rods dead soft, st'l	£11	0	0 to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Current Discounts.

	Tubes.	*Fittings.*
Gas	62½%	57½%
Water ..	58½%	52½%
Steam ..	55%	47½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
May	28 ..	36	16	3	dec.	7/6
,,	29 ..	36	2	6	,,	13/9
June	1 ..	35	16	3	,,	6/3
,,	2 ..	35	1	3	,,	15/-
,,	3 ..	34	7	6	,,	13/9

Electrolytic Copper.

		£	s.	d.		
May	28 ..	39	10	0	dec.	20/-
,,	29 ..	39	10	0	No change	
June	1 ..	40	0	0	inc.	10/-
,,	2 ..	39	0	0	dec.	20/
,,	3 ..	39	0	0	No change	

Standard Tin (cash).

		£	s.	d.		
May	28 ..	101	7	6	dec.	22/6
,,	29 ..	100	12	6	,,	15/-
June	1 ..	100	12	6	No change	
,,	2 ..	100	12	6	,,	,,
,,	3 ..	100	7	6	dec.	5/-

Tin (English ingots).

		£	s.	d.		
May	28 ..	102	10	0	dec.	20/-
,,	29 ..	101	15	0	,,	15/-
June	1 ..	101	15	0	No change	
,,	2 ..	101	15	0	,,	,,
,,	3 ..	101	10	0	dec.	5/-

Zinc Sheets (English).

		£	s.	d.		
May	28 ..	20	0	0	No	change
,,	29 ..	20	0	0	,,	,,
June	1 ..	20	0	0	,,	,,
,,	2 ..	20	0	0	,,	,,
,,	3 ..	20	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
May	28 ..	10	6	3	dec.	2/6
,,	29 ..	10	0	0	,,	6/3
June	1 ..	9	18	9	,,	1/3
,,	2 ..	9	16	3	,,	2/6
,,	3 ..	9	13	9	,,	2/6

Lead (English).

		£	s.	d.		
May	28 ..	12	10	0	dec.	5/-
,,	29 ..	12	0	0	,,	10/-
June	1 ..	12	5	0	inc.	5/-
,,	2 ..	12	5	0	No change	
,,	3 ..	12	0	0	dec.	5/-

AVERAGE MONTHLY PRICES OF STEEL SHIP ANGLES (NORTH OF ENGLAND).

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	4 15 0	4 17 6	5 0 0	5 0 0	5 0 0	4 17 6	4 17 6	4 17 6	4 17 6	5 0 0	5 7 6	5 7 6	4 19 9½
1897	5 7 6	5 7 6	5 7 6	5 5 0	5 0 0	5 0 0	5 2 6	5 2 6	5 2 6	5 2 6	5 0 0	5 5 0	5 3 5½
1898	5 5 0	5 5 0	5 5 0	5 7 6	5 13 9	5 15 0	5 15 0	5 15 0	5 17 6	6 0 0	6 5 0	6 7 6	5 14 3
1899	6 10 0	6 12 6	6 15 0	6 15 0	6 17 6	6 17 6	7 0 0	7 0 0	7 5 0	7 5 0	7 12 6	7 15 0	7 0 5
1900	7 15 0	8 0 0	8 2 6	8 5 0	8 5 0	8 7 6	8 7 6	8 2 6	8 2 6	8 0 0	7 10 0	7 10 0	8 0 7½
1901	6 15 0	6 12 6	6 5 0	6 0 0	6 0 0	5 10 0	5 15 0	5 17 6	6 0 0	5 17 6	5 17 6	5 15 0	6 0 5
1902	5 12 6	5 10 0	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 11 8
1903	5 6 3	5 6 3	5 7 6	5 12 6	5 12 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 0 0	5 8 9
1904	5 0 0	4 17 6	5 2 6	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 0 0	5 0 0	5 0 0	5 5 0	5 2 6
1905	5 5 0	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 12 6	6 2 6	6 12 6	6 12 6	5 14 4½
1906	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	7 2 6	6 13 4
1907	6 17 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	6 12 6	6 12 6	7 0 5
1908	6 2 6	6 2 6	6 2 6	5 17 6	5 17 6	5 17 6	5 17 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 16 3
1909	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 9 7
1910	5 16 3	5 17 6	5 17 6	6 1 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 7 6	6 7 6	6 7 6	6 2 3½
1911	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 9 0	6 7 8½
1912	6 16 3	6 17 6	6 17 6	7 5 0	7 7 6	7 7 6	7 7 6	7 12 6	7 12 6	7 12 6	7 14 6	7 17 6	7 7 4½
1913	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 11 6	7 7 6	6 15 6	6 7 6	6 2 6	7 8 11½
1914	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	5 15 0	5 15 0	6 15 0	7 0 0	7 0 0	7 1 3	7 5 0	6 8 7½
1915	7 17 0	8 5 0	8 17 6	9 5 0	9 5 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	10 15 0	10 15 0	9 8 3½
1916	11 3 1½	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1917	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1918	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6½
1919	11 2 6	13 12 6	13 12 6	13 12 6	17 2 6	17 1 3	17 0 0	17 15 0	17 15 0	17 15 0	17 17 6	18 5 0	16 1 9
1920	19 10 0	20 0 0	21 10 0	22 0 0	23 5 0	24 0 0	24 0 0	24 0 0	24 15 0	24 10 0	24 0 0	24 0 0	22 19 2
1921	22 10 0	20 12 6	19 0 0	17 10 0	17 10 0	16 6 0	14 10 0	14 3 4	13 10 0	11 15 0	10 0 0	9 12 6	15 11 7
1922	9 17 6	10 0 0	10 0 0	10 0 0	10 0 0	9 17 6	9 10 0	8 15 7½	8 14 0	8 12 6	8 12 6	8 12 6	9 7 8½
1923	8 18 1½	9 1 3	9 14 0	10 0 0	10 0 0	10 0 0	9 8 9	9 9 6	9 10 0	9 8 9	9 11 6	9 18 9	9 11 8½
1924	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 5 0	9 13 1½
1925	9 2 0	9 0 11½	9 0 0	8 15 9	8 10 3½	8 9 0½	8 6 3	8 2 6	7 19 0½	7 12 3	7 5 0	7 2 6	8 5 5½
1926	7 2 6	7 2 6	7 2 6	7 3 4	7 2 6	7 3 9	7 7 6	7 8 5½	7 9 0	7 12 6	7 16 3	8 0 6	7 7 7½
1927	7 18 9	7 17 6	7 17 6	7 14 8½	7 13 9	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 14 1½
1928	7 12 6	7 14 9	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 16 10½
1929	7 17 6	7 17 6	7 17 6	7 17 6	8 0 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 5 0	8 0 10½
1930	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1931	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	—	—	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS WANTED.

EXPERIENCED Foundry Trade Traveller desires position as Representative for Lancashire or the Midlands. Thoroughly practical and well known; extensive experience in refractories and moulding machines; member I.B.F.—Box 810, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Any Member, Associate Member or Associate of the Institute of British Foundrymen who desires his qualifications to be inserted in the column must forward to the General Secretary of the Institute the following information:—(a) Name and address; (b) name of present employer (or last employer if unemployed); (c) brief particulars of qualifications, experience, and type of position required. The name will not be disclosed until the candidate is in communication with a prospective employer. Announcements will be inserted in two successive issues, unless announcers' requirements have been met with in the meantime.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

The Institute of British Foundrymen and the Proprietors of THE FOUNDRY TRADE JOURNAL wish it to be clearly understood that they accept no legal responsibility in connection with this service, for which no charge is made to members of the I.B.F.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester.

FOUNDRY Manager or Foreman seeks re-engagement. Exceptionally varied experience in modern foundry practice. Plate and machine moulding, also jobbing; pipes and high-class rollers. Technical training. Has a good speciality to offer to foundries. (115)

POSITION required as Foundry Manager or Foreman; 15 years in supervisory positions. Hydraulic, motor gearing, general engineering and jobbing, also repetition work; up-to-date cupola practice, special irons and semi-steel. (116)

METALLURGIST and Chief Chemist for malleable and grey or special iron foundry requires position. Specialist in producing cheap irons, heat-treatments, white- or black-heart malleable. Birmingham district preferred. (117)

METALLURGIST requires engagement. Experience in steelworks and irons and non-ferrous foundry analyses, also alloys, rubbers, etc.; control of foundry operations, sands, melting, and casting, microscopic. Sound technical training. (118)

MOULDER, with first-class experience on high-grade castings for turbine Diesel work, also general engineering, desires position as foreman or other supervisory position with prospects. (119)

PROGRESSIVE Position required in Roll or engineering foundry. Sound experience in chilled and grain rolls, including metal mixtures, also general engineering castings. (120)

SITUATIONS WANTED—*Continued.*

FOUNDRY Manager desires re-engagement. Expert knowledge patternmaking, machine and plate moulding, and general jobbing work, also baths. Excellent references. (121)

POSITION required as Commercial Assistant or Representative. Foundry and machine-moulding knowledge, experience marine turbines and oil-burning installations. Store-keeping. (122)

POSITION required as Foreman or Foundry Manager; wide experience in steam, engine, textile, and general engineering castings. Technically trained. (123)

METALLURGIST and Chief Chemist requires position. Blast-furnace and foundry experience. Honours Medallist, City and Guilds. Research Medallist, S.I. & S.I. (124)

PROPERTY.

MAGNIFICENT

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of Shops.

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

PATENT.

THE Proprietors of the Patent No. 226751 for Improvements in or relating to Processes for Incorporating Manganese with Iron are desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting same and ensuring its full development and practical working in this country—All communications should be addressed, in first instance, to HASELTINE, LAKE & COMPANY, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

MACHINERY.

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Station Works, Ecclesfield, Sheffield.

THOS. W. WARD, LTD.

No. 60 and No. 70 HEALD Internal Grinders.

16¼-in. Swing CHURCHILL Internal Grinder; ⅞-in. hollow spindle.

10-in. x 24-in. CHURCHILL Universal Grinder, with Internal Attachment.

10-in. x 24-in. WARD Universal Grinder.

30-cwt. STEAM TRAVELLING GANTRY JIB CRANES (Coles), 50-ft. jib, to lift 30 cwts. at 42-ft. radius.

12-ton LOCO. STEAM CRANE (Ransome & Rapier), constructed to lift 12 tons at 25-ft. radius; 9-ft. gauge; 80 lbs. w.p.

New "POPULAR JUNIOR" BOILER, 5 ft. 6 in. high x 2 ft. 6 in. dia.; 100 lbs. pressure.

Large stock of very good Secondhand FLAT-ENDED CIRCULAR BOILER STORAGE TANKS.

About 3,500 ft. of New slightly stock-rusty 1½-in. dia. Screwed and Socketed PIPING in the usual long random lengths.

(ASK FOR "ALBION" MACHINERY CATALOGUE.)

ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued.*

ONE Sand Slinger by J. W. Jackman & Company. One "Geiger" Sand Slinger. Motors are 3-phase, 50 cycles, 440 volts.—Reply to CRANE-BENNETT, LIMITED, Nacton Works, Ipswich.

UNIVERSAL Mixers for Sand Colours, Chemicals, Blacklead, etc., different sizes. Also Super Abrasive Grinders and Steel Attrition Grinder and Dresser. Grind to any degree of fineness.—BOOTH & SON, Grinding, Crushing and Mixing Engineers, Congleton, Cheshire.

MISCELLANEOUS.

GANISTER, best quality for cupolas, also for Steel Works.—ASTBURY SILICA COMPANY, "The Brooms," Park Lane, Congleton.

CORE Oven (Jackman), 4 ft. x 3 ft. x 3 ft., price £3.—PLASTIC MOULDING COMPANY, LIMITED, 104, Albion Road, N.16.

RAILWAY CASTINGS WANTED; 10 lbs. to 1½ cwts., grey iron only. Will interested foundries send details of experience and production of this class of work?—Box 808, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

LINSEED OIL.—Re-tanked Linseed Oil, about 5 to 10 tons, for sale, £22 per ton ex-Hull; 3 tons also ex-Glasgow.—Write, Box 792, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

'Phone: 287 SLOUGH

SAND PLANT

IN STOCK

Small Jackman SM4 Aerator...	£12
Halls "Invincible" mixer ...	£18
"Herbert" mixer, as new ...	£32
All above BALL BEARING.	
5 ft. Universal Sandmill... ...	£26
6 ft. "Jackman" sandmill ...	£38
Pneulec Oilsand Mixer, type PM	£14
"Macdonald" air riddle as new	£10

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

Bradley's

MIXTURE SERVICE

The Bradley Mixture Service is designed to enable the full benefit of Refined Irons, their unique properties, uniformity of quality and composition, to be available to the general foundry public.

The service is based upon a standard series of Refined Irons of guaranteed composition of which a stock is held continuously available at twenty-four hours' notice.

Full particulars of the Bradley Mixture Service are contained in an interesting booklet, a copy of which will be sent free on request.

BRADLEY & FOSTER LIMITED
IRONMASTERS
DARLASTON, STAFFS

Telegrams: "Bradley, Darlaston." Telephone: Darlaston 16 (P.B. Ex.)